SOUTHWEST COASTAL LOUISIANA
REVISED INTEGRATED DRAFT FEASIBILITY REPORT
AND
ENVIRONMENTAL IMPACT STATEMENT

APPENDIX A

ENVIRONMENTAL REPORT

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Environmental Report

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INTRODUCTION

The low elevation and proximity to the Gulf of Mexico put the unique environment and cultural heritage of southwest Louisiana communities at risk from storm surge flooding and coastal erosion. Land subsidence and rising sea levels are expected to increase the potential for coastal flooding, shore erosion, saltwater intrusion, and loss of wetlands and chenier habitats.

Purpose of Action and Scope

The study purpose is to evaluate coastal storm flood damages and coastal ecosystem degradation in Cameron, Calcasieu, and Vermilion parishes in Louisiana. The intent is to develop potential solutions to these water resource problems. The impacts described for the National Economic Development (NED) hurricane and storm surge damage reduction objective are programmatic in nature. Subsequent National Environmental Policy Act (NEPA) documents will analyze in detail site specific project(s) impacts prior to implementation. The National Ecosystem Restoration (NER) features have been revised to full feasibility-level and are recommended as fully constructible and fully NEPA compliant.

Federal Objectives

The Federal objective of water and related land resources planning is to provide the greatest net contribution to NED consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. The ecosystem objective is to contribute to NER by restoring function and structure to significant ecological resources.

Need for Action

The processes of sea level rise, subsidence, saltwater intrusion, and erosion of wetlands in southwest coastal Louisiana have caused significant adverse impacts, including increased rates of wetland loss and ecosystem degradation. Without action, this highly productive coastal ecosystem, composed of diverse habitats and wildlife, is not sustainable. Infrastructure constructed for access into and across the wetlands has modified the hydrology of the coastal zone, thus facilitating and accelerating saltwater intrusion and fragmentation, and conversion of wetlands to open water. Hurricane surge has formed ponds in stable, contiguous marsh areas and expanded existing, small ponds, as well as removed material in degrading marshes (Barras, 2009). Fresh and intermediate marshes appear to be more susceptible to surge impacts, as observed in Barras (2006).

Land loss and ecosystem degradation threaten the continued productivity of the area's ecosystems, the economic viability of its industries, and the safety of its residents. The following valuable social and economic resources are at risk:

- Commercial harvest of fishery resources
- Rice, crawfish, and cattle farming
- Recreational saltwater and freshwater fisheries
- Ecotourism
- Oil and gas production
- Petrochemical industries
- Strategic petroleum reserve storage sites
- Storm damage risk reduction, including hurricane storm buffers
- Navigation corridors and port facilities for commerce and national defense, and
- Actual and intangible value of land passed down through generations.

During the NEPA scoping process, stakeholders noted the following problems related to saltwater intrusion:

- As the Calcasieu Ship Channel widens and deepens, salinity levels increase after storm surge events and farmers have greater difficulty operating their rice farms.
- In the 2006 growing season, farmers were unable to plant because of high salinity levels caused by Hurricane Rita which overtopped local levees built in the 1940s or early 1950s.
- As a result of salinity encroachment in Calcasieu Lake, the Sabine Refuge is now a large open water area.

- Saltwater intrusion is occurring in the Calcasieu and Mermentau Basins and is in turn negatively impacting the seafood industry. Ship channels in the Calcasieu and Sabine Rivers are allowing saltwater movement into the upper estuaries.

Comments on the Integrated Feasibility Report and Draft Programmatic Environmental Impact Statement were requested during the 45-day comment period from December 13, 2013, to January 27, 2014, which was extended until February 13, 2014. The CEMVN received 11 written comments (emails, faxes, and letters) from Federal, state, parish and local governments; and 31 written comments from members of the public. Many of the written comments contained multiple comments. Some of the comments had attachments. A total of 578 individual comments were received. The major themes of the comments included: largest number of individual comments, primarily editorial, came from the CPRA; USACE SMART Planning procedures; request levee/structural protection or risk reduction; request consideration of agriculture, Henry Hub and other commercial industrial assets in benefit/cost calculations for structural risk reduction; non-structural risk reduction not wanted; levee "discrimination" (e.g., protect wetlands but not people); ecosystem restoration; increasing salinities; Calcasieu Ship Channel; and cheniers.

During the past 11 years, the area has been greatly impacted by storm surges associated with three Category 2 or higher hurricanes -- Lili, Rita, and Ike -- which inundated structures and resulted in billions of dollars in damages to southwest coastal Louisiana. Hurricane surge also causes significant damage to wetlands. The breakup of marshes surrounding the towns and communities is allowing storm surge and inundation to more directly impact habitable areas. As a consequence, smaller storms are able to inflict significant flooding damages to residential and non-residential structures. As the coastal ecosystem continues to fragment, flooding losses are expected to increase, thus placing larger populations at risk.

1.0 Affected Environment

Study Area

The study area (Figure 1-1) is located in southwest Louisiana and includes all of Calcasieu, Cameron, and Vermilion parishes encompassing approximately 4,700 square miles.

Cameron Parish is located in the southwest corner of Louisiana. The southern boundary of the parish is the Gulf of Mexico. Eighty-two percent of Cameron Parish is coastal marshes. Geographically, it is one of the largest parishes in Louisiana. The parish is chiefly rural and the largest communities are Cameron and Hackberry. Cameron is located along LA-82, while Hackberry is located along LA-27. Other smaller communities include Creole, Johnsons Bayou, and Holly Beach.

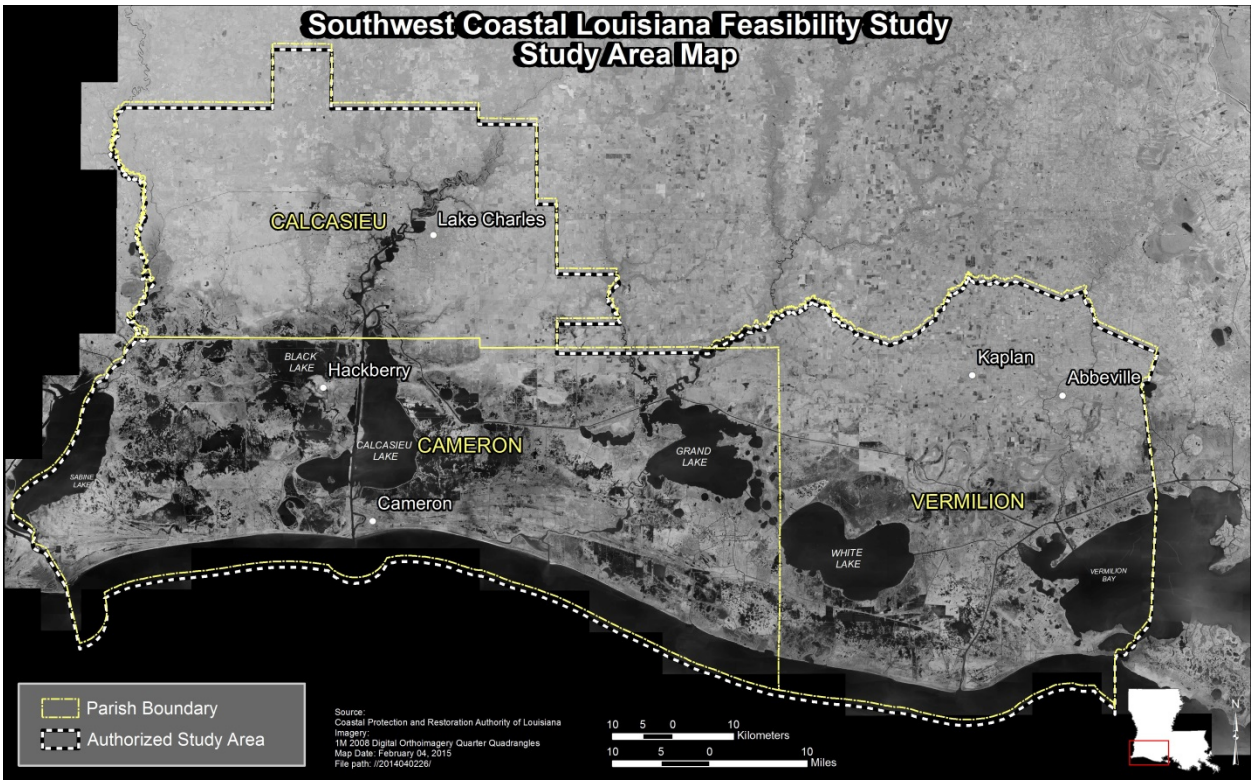

Figure 1-1: Study area.

Calcasieu Parish is located due north of Cameron Parish. The town of Lake Charles is the parish seat, which is the largest urban area in the study area. Only a small portion of the parish is located in the coastal zone.

Vermilion Parish is located due east of Cameron Parish. The southern boundary of the parish is the Gulf of Mexico. Large expanses of Vermilion Parish area open water (lakes, bays, and streams). Approximately 50 percent of the land is coastal marshes. The parish is chiefly rural and the town of Abbeville is the parish seat as well as the largest urban area in the parish. Other communities include Delcambre, Kaplan, and Gueydan, which are all located along LA-14 in the northern part of the study area. Pecan Island and Forked Island are smaller communities, both located along LA-82 in lower Vermilion Parish. Located along LA-333, Intracoastal City is the nearest access to Vermilion Bay and the Gulf of Mexico in this region and supports the area's oil and shrimp industries.

Figure 1-2 displays land class changes within the study area between 1956 and 2000. Table 1-1 displays the study area habitat classification in 2000 (source: USGS Map ID USGS-NWRC 2014-11-0001 Map Date: October 18, 2013). This information, derived for the present study, was taken from a data set that does not include areas outside the Coastal Zone; hence the large areas categorized as "Out of Analysis".

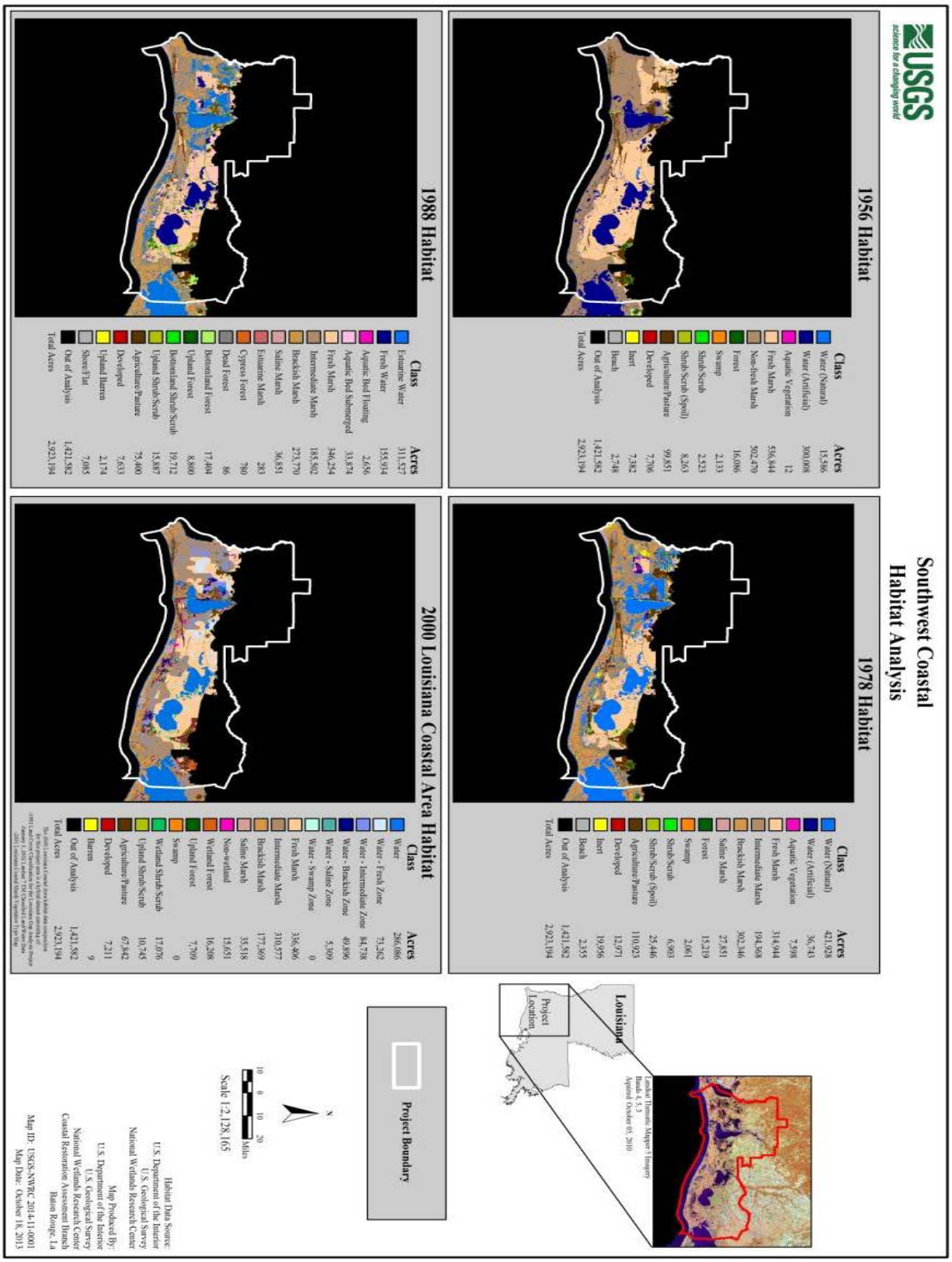

Figure 1-2: Land class (habitat) changes between 1978-2000 (source: USGS 2013).

Table 1-1. Year 2000 area habitat classification.

Habitat Class	Acres	Percent of Project Area
Water	286,086	9.79%
Water - Fresh Zone	73,262	2.51%
Water - Intermediate Zone	84,736	2.90%
Water - Brackish Zone	49,896	1.71%
Water - Saline Zone	5,309	0.18%
Water - Swamp Zone	0	0.00%
Fresh Marsh	336,406	11.51%
Intermediate Marsh	310,577	10.62%
Brackish Marsh	177,369	6.07%
Saline Marsh	35,518	1.22%
Non-wetlands	15,651	0.54%
Wetland Forest	16,208	0.55%
Upland Forest	7,709	0.26%
Swamp	0	0.00%
Wetland Shrub/Scrub	17,076	0.58%
Upland Shrub/Scrub	10,745	0.37%
Agriculture/Pasture	67,842	2.32%
Developed	7,211	0.25%
Barren	9	0.00%
*Out of Analysis	1,421,582	48.63%
Total Acres	2,923,194	

*Out of analysis—this area, primarily north of the Coastal Zone, was not included in the original data set from which the data is derived **(Source: USGS Map ID USGS-NWRC 2014-11-0001 Map Date: October 18, 2013).**

Geomorphic and Physiographic Setting

The study area occupies a portion of the Pleistocene Prairie Terrace (or Prairie Complex) on the northern edge of Cameron, the northern half of Vermilion, as well as the majority of Calcasieu Parishes, and most of the Marginal Plain (or Chenier Plain) on the far southern portions of Calcasieu, most of Cameron and southern half of Vermilion Parishes. The main physiographic zones of the Chenier Plain include the Gulf Coast Marsh, Gulf Coast Prairies, and Forested Terraced Uplands. The Gulf Coast Marsh is at or near sea level and borders the Gulf of Mexico and most of the large lakes in the area. The Gulf Coast Prairie extends from the central part of Vermilion and Cameron Parishes into the southern part of Calcasieu Parish, while the Forested Uplands, which occur at or near 25-foot elevation, are located in the northern part of Vermilion and Calcasieu Parishes. Louisiana's coastal prairies, once encompassing an estimated 2.5 million acres in the Southwest portion of the state, now are considered critically imperiled with less than 600 acres remaining.

The study area formed over the past 7,000 years by the deltaic processes of the Mississippi River and other streams. Fine-grained sediment transported to the Chenier Plain in the mud stream from the Mississippi River was brought into coastal estuaries and marshes and deposited along the shore to form mudflats (Gagliano and van Beek, 1993). The newly formed land was then colonized by wetland vegetation, which further promoted the land-building process. Wave action and occasional storm events also deposited sand and shells onto the newly built land. As the Mississippi River changed course and active delta-building switched to the eastern Deltaic Plain, or extended to the edge of the continental shelf or beyond (current course), the mud stream ceased to carry sediment to the Chenier Plain and the Gulf shore became subject to erosion. Periods of erosion winnowed out fine-grained materials, leaving the deposits of sand and shell to form the Gulf beaches, examples of such in the area are Holly and Rutherford Beaches. Beach deposits were subsequently shaped by waves and coastal currents to form elevated ridge systems. Once the mud stream returned and land-building

continued seaward, these elevated ridges or cheniers (forests atop relict beach ridges) were stranded inland where deciduous vegetative growth (e.g., live oak trees) occurred. Examples of cheniers in the area include Hackberry, Little Chenier, Grand Chenier, Pecan Island and Cheniere au Tigre ridges to name just a few. These ridges and cheniers blocked drainage and saltwater inflows from the Gulf of Mexico, resulting in the development of large freshwater basins on the landward side of the ridges. Chenier ridges run laterally to the modern shoreline and rise above the surrounding marshes by as little as a few inches or as much as 10 feet (Byrne et al. 1959). These ridges can range from 100 to 1,500 feet wide with some ridges extending along the coast for a distance of up to 30 miles. On the seaward side of the cheniers, a zone of brackish to saline marshes developed as a result of tidal influences from the Gulf (adapted from Visser et al. (2000), USACE (2004), and LADNR (2009)).

Climate

The climate is subtropical marine with long humid summers and short moderate winters. The average temperatures range from 59 to 78°F; with August being the warmest and December the coolest. Average annual rainfall is 57 inches; with June the wettest and April the driest month (Source: http://www.srh.noaa.gov/lch/?n=KLCH, accessed August 30, 2013). During the summer, prevailing southerly winds produce conditions favorable for afternoon thundershowers. In the colder seasons, the area is subjected to frontal movements that produce squalls and sudden temperature drops. River fogs are prevalent in the winter and spring when the temperature of the major waterbodies is somewhat colder than the air temperature. Since 1865 a total of 16 hurricanes have made landfall within 65 nautical miles of Lake Charles (source:http://csc.noaa.gov/hurricanes/#app=6078&7239-selectedIndex=0&3722-selectedIndex=0, accessed August 30, 2013).

1.2 Human Environment

Communities include the cities of Lake Charles and Sulphur; the towns of Vinton and Iowa in Calcasieu Parish; the towns of Cameron, Grand Lake, Hackberry, and Grand Chenier in Cameron Parish; and the city of Abbeville, the towns of Erath, Kaplan, and Pecan Island in Vermilion Parish; and the town of Delcambre in Vermilion and Iberia parishes. These parishes have historically suffered extensive damage from hurricanes and tropical storms due to insufficient hurricane and storm damage risk reduction features. The impact of preparing for, mitigating, and recovering from these damages has placed a significant physical and emotional burden on both individuals and communities. Most recently, Hurricanes Rita (2005) and Ike (2008) caused significant damage to homes and businesses. In this section, socioeconomic and other social effects (OSE) data for Calcasieu, Cameron, and Vermilion Parishes provide a context from which to evaluate potential effects of the proposed action.

1.2.1 Population and Housing

Table 1-2 shows the population trend in the three-parish area from 1970 to 2012. Population increases between 2000 and 2010 reflect similar growth patterns state-wide over this period. Population in the three-parish area in 2012 was 259,918, although there was a decline of population in Cameron Parish from 2000 to 2012.

Table 1-2: Population in the study area.

PARISH	1970	1980	1990	2000	2010	2012
Calcasieu	145,415	167,223	168,134	183,577	192,768	194,493
Cameron	8,194	9,336	9,260	9,991	6,839	6,702
Vermilion	43,071	28,458	50,055	54,014	57,999	58,723
Total	196,680	205,017	227,449	247,582	257,606	259,918

Sources: U. S. Census, 2010 and U.S. Census Abstract, 2013

The trend in household formation, shown in Table 1-3, parallels the growth in population. Most households are located in the metropolitan areas which include: Lake Charles in Calcasieu Parish; Cameron (which serves as the seat of government in Cameron Parish); and Abbeville located in Vermilion Parish.

Table 1-3: Households (in thousands) in the study area.

PARISH	1970	1980	1990	2000	2010	2012
Calcasieu	42.1	56.8	60.4	68.6	70.6	72.2
Cameron	2.3	3.0	3.1	3.6	2.5	2.4
Vermilion	12.8	16.3	17.7	19.9	21.1	21.6
Total	57.2	76.1	81.3	92.1	94.2	96.2

Sources: U. S. Census, 2010 and U.S. Census Abstract, 2013

According to the Federal Emergency Management Agency, flood claims from all sources for the three-parish area between 1978 and 2012 totaled $420,900,000. See Table 1-4.

Table 1-4: Summary of flood claims data for the Period 1978 to 2012.

PARISH	CLAIMS	TOTAL NOMINAL DOLLAR AMOUNT (IN MILLIONS)	AVERAGE AMOUNT PER CLAIM
Calcasieu	4,008	$132.0	$32,930
Cameron	3,061	173.5	56,679
Vermilion	3,218	115.4	35,860
Total	10,287	420.9	$41,823

Source: FEMA 2013

1.2.2 Employment, Business, and Industrial Activity

Table 1-5 shows the growth of non-farm employment in the three-parish area. The leading employment sectors are education, healthcare, petroleum production, and petrochemical refining. Other significant employment sectors include education, manufacturing, accommodations and social services, and retail trade. Employment growth was steady from 1970 to 2012 for Calcasieu and Vermilion parishes, although employment in Cameron parish declined since 2000, and is reflected in the population estimates previously described.

Table 1-5: Non-farm employment in the study area (in thousands)

PARISH	1970	1980	1990	2000	2010	2012
Calcasieu	41.1	67.0	69.0	84.6	87.9	93.3
Cameron	2.8	4.4	4.1	3.9	2.6	2.7
Vermilion	9.4	16.6	13.3	14.7	15.5	16.9
Total	53.3	88.0	86.4	103.2	106.0	112.9

Source: Moody's, 2013

Table 1-6 displays the percentage breakdown of non-farm employment by industry for each parish in the study area.

Table 1-6: Non-farm employment by industry (2010)

Industry	Calcasieu	Cameron	Vermilion
Forestry, fishing, and related activities	0%	6%	3%
Mining	1%	6%	7%
Utilities	0%	X	0%
Construction	9%	7%	8%
Manufacturing	8%	10%	6%
Wholesale trade	2%	8%	3%
Retail trade	11%	X	13%
Transportation and warehousing	3%	11%	3%

Information	1%	X	1%
Finance and insurance	3%	X	4%
Real estate and rental and leasing	3%	X	4%
Professional, scientific, and technical services	5%	X	3%
Management of companies and enterprises	1%	X	0%
Administrative and waste management services	5%	3%	3%
Educational services	1%	1%	X
Health care and social assistance	12%	3%	X
Arts, entertainment, and recreation	2%	X	1%
Accommodation and food services	10%	X	5%
Other services, except public administration	6%	4%	9%
Federal, civilian	1%	1%	1%
Military	1%	1%	1%
State government	3%	2%	1%
Local government	10%	19%	14%

Source: Bureau of Economic Analysis (BEA)
An "X" denotes that data is not available for an entry.

Approximately 32% of the land area is used for agriculture. The major crops grown in the area are rice, soybeans, sugarcane, and sorghum. Pecans are also a major crop in Cameron Parish. According to the 2007 Census of Agriculture, the total stock of crops in the area is valued at over $62 million, with Vermillion Parish accounting for 80% of the total crop value.

1.2.3 Public Facilities and Services

Public facilities and services have historically grown to meet population demands. The area includes a mixture of community centers, schools, hospitals, airports, colleges, and fire protection. The Port of Lake Charles is a key center for international trade, and is among the top 15 busiest ports in the nation. A total of 603 public and quasi-public buildings were specifically inventoried in the three-parish area in 2012

1.2.4 Transportation

The transportation infrastructure includes major roads, highways, railroads, and navigable waterways that have developed historically to meet the needs of the public. Interstate 10 (I-10), an east-west bi-coastal thoroughfare that connects Houston and Baton Rouge, crosses the northern part of the area and is a primary route for hurricane evacuation and post-storm emergency response. US-165, another evacuation and emergency response route, is located north of I-10. Most of I-10 is either at or just below the 100-year floodplain [1% Annual Chance Exceedance (ACE)]. Other major highways include US-13 and US-26, which runs north-south and intersects I-10 in the northeastern portion of the parishes.

Other modes of transportation include water transport along the GIWW and the Sabine and Calcasieu Rivers, all of which accommodate ocean-going vessel and barge traffic. Rail and aviation facilities are spread throughout.

During Hurricanes Rita and Ike, portions of I-10 were inundated by a combination of storm surge and rainfall. This interfered with emergency service access and prevented local and regional residents from returning to their primary residences and businesses. This delay in repopulation results in additional emergency costs, due to the longer time periods required for sheltering residents until the area was made safe to return.

1.2.5 Navigation Projects

Navigational channels in the chenier plain influence hydrology, primarily by increasing marine influences (saltwater intrusion, wave energies) into freshwater and other interior marshes (LCA, 2004). The following navigation waterways are in the vicinity of the Southwest Coastal Louisiana feasibility study area:

- Gulf Intracoastal Waterway (GIWW)
- Sabine-Neches Waterway
- Calcasieu River and Pass
- Mermentau River
- Freshwater Bayou
- Bayou Teche and Vermilion River

1.2.5.1 Gulf Intracoastal Waterway

The GIWW traces the U.S. coast along the Gulf of Mexico from Apalachee Bay near St. Marks, FL to Brownsville, TX, near the Mexico border. It intersects the Mississippi River and extends eastward for approximately 376 miles and west-southwestward for approximately 690 miles. In the study area, the approximate distances between major crossings are as follows:

- Atchafalaya River to Vermilion River, 64 miles;
- Vermilion River to Mermentau River, 43 miles;
- Mermentau River to Calcasieu River, 37 miles;
- Calcasieu River to Sabine River, 27 miles.

In addition to its main stem, the GIWW (Figure 1-3) includes a major alternative route (64 miles) which connects Morgan City, LA to Port Allen, LA. Project dimensions for the main stem channel and the alternative route are 12 ft deep and 125 ft wide, except for the reach between the Mississippi River and Mobile Bay, which is 150 ft wide. Today, parts of the GIWW are deeper and wider than the original construction dimensions.

Figure 1-3 Gulf Intracoastal Waterway Mainstem and Alternate Route

The GIWW was first authorized and construction began in the 1920s. The project was authorized by the River and Harbor Act of July 24, 1946, Senate Document 242, 79th Congress, 2nd Session, and prior River and Harbor Acts. The primary purpose of the inland navigation channel is transportation of goods by barge.

Numerous side channels and tributaries intersect both the eastern and western main stem channel, providing access to inland areas, coastal harbors, and the Gulf of Mexico. The USACE operates the Leland Bowman Lock located on the GIWW. The lock helps to regulate the flow of water in the Mermentau Basin and keeps salt water out of the fresh water supply that serves the farming communities further north, while allowing barge transportation.

1.2.5.2 Sabine-Neches Waterway and Sabine Pass Ship Channel

The Sabine-Neches Waterway is an approximately 64-mile federally authorized and maintained waterway located in Jefferson and Orange Counties in southeast Texas and Cameron Parish, Louisiana. The Sabine Pass, Sabine Lake, and Sabine River together form part of the boundary between the states of Texas and Louisiana. The Sabine-Neches main channel dimensions are currently 40 feet deep and 400 feet wide. The existing waterway consists of a jettied entrance channel, 42 feet deep and 500 to 800 feet wide, from the Gulf of Mexico; a channel 40 feet deep and 400 feet wide to Beaumont via the Neches River; and a channel 30 feet deep and 200 feet wide to Orange via the Sabine River.

The Sabine-Neches Project was authorized by the River and Harbor Act of 1962, House Document No. 553, 87th Congress, 2nd Session. The Sabine-Neches Waterway and the Sabine Pass Ship Channel serve the ports of Port Arthur, Beaumont, and Orange, Texas in the movement of commodities, particularly crude petroleum.

The USACE Galveston District is currently investigating navigation improvements on the Sabine-Neches Waterway. A draft report has been circulated for public review which tentatively recommends a channel modification to a depth of 48 ft. The project modification process is described in more detail in the chapter on Existing and Future Without Project Conditions.

1.2.5.3 Calcasieu River and Pass

The Calcasieu River is a 68-mile, deep-draft navigation channel. The northern boundary of the ship channel is located at Mile 36.0, just south of Interstate 10 in Lake Charles, LA. The southern boundary extends to Mile (-32.0) in the Gulf of Mexico.

The project was authorized under the River & Harbor Act of July 14, 1960 House Document 436, 86th Congress, 2nd Session (USACE). The purpose of this project is to provide deep-draft access to the Port of Lake Charles, the 12th largest port in the U.S. based on tonnage. The project also provides for a Saltwater Barrier Structure located north of Lake Charles, approximately 3 miles north of the northern boundary of the deep-draft ship channel.

1.2.5.4 Mermentau River

The Mermentau River navigation channel is a 4.6-mile channel beginning at the point of entry of the Mermentau River into Lower Mud Lake and extends in a southerly direction to the Gulf of Mexico.

The project includes two salinity control structures: the Catfish Point Control Structure located at Mile 24 of the Mermentau River, and the Schooner Bayou Control Structure located in the enlarged White Bay to Vermilion Bay channel, approximately 5 miles southwest of Intracoastal City. The Catfish Point and Schooner Bayou Control Structures reduce saltwater intrusion into the Mermentau Basin, which consists of hundreds of thousands of acres of rice and crawfish farms that are dependent on freshwater.

The project is authorized by the Flood Control Act of August 18, 1941, as modified by the River and Harbor Act of July 24, 1946. The Act provides for enlargement of the lower Mermentau River below Grand Lake to a minimum cross-sectional area of 3,000 sq ft below Mean Low Gulf (MLG) for discharge of flows. It also provides for channel enlargement and realignment of the Inland Waterway from Vermilion Bay to Grand Lake to provide a minimum cross-sectional area of 3,000 sq ft below MLG for discharge of flood flows and interflow between lakes.

This project also provides for the enlargement of the North Prong of Schooner Bayou and Schooner Bayou Cutoff to a channel -6 ft MLG by 60 ft. It also provides for a sector gated control structure at Catfish Point,

Mile 24 of the Mermentau River, and Schooner Bayou Lock on Schooner Bayou. The Act further provides for incorporation of the existing projects: "Waterway from White Lake to Pecan Island, LA" and the portion of "Inland Waterway from Franklin, LA to the Mermentau River" west of Vermilion Bay. The waterway from "Inland Waterway from White Lake to Pecan Island, LA" consists of a channel -5 ft MLG by 40 ft.

1.2.5.5 Freshwater Bayou and Freshwater Bayou Lock

Freshwater Bayou is a 23.1-mile navigation channel that serves as the hydrologic boundary between the Mermentau Basin to the west and the Teche-Vermilion Basin to the east. The canal extends from the northern boundary at Mile 161.2 of the GIWW, at Intracoastal City west of the Harvey Lock, to the 12-ft depth contour in the Gulf of Mexico.

A lock is located at the Gulf of Mexico to aid in reducing saltwater intrusion into interior wetlands along the canal. Between 1979 and 1986, approximately 300,000 tons of cargo was transported along Freshwater Bayou Canal, mostly in oil and gas service and supply vessels and commercial fishing boats (USACE, 1989).

The project was authorized under the River and Harbor Act of July 14, 1960 (USACE Project Fact Sheet) and constructed between 1965 and 1967. The purpose of this project is to provide deep-draft vessels access between the Gulf of Mexico and Intracoastal City, Abbeville Harbor and Terminal District, and the GIWW.

1.2.5.6 Bayou Teche and Vermilion River, LA

The Vermilion River is a 131.8-mile navigable channel that flows from the 8-foot (ft) contour in Vermilion Bay to the head of navigation at Mile 52 at Lafayette, LA. There is a flood control project from Lafayette to Port Barre, LA, as well as in Bayou Teche from 2 miles below Arnaudville to Port Barre (USACE Project Fact Sheet).

The project was authorized by the Flood Control Act of August 18, 1941 (USACE Project Fact Sheet). The purpose of this project is to provide a shallow-draft navigation channel to Lafayette and improve flood control from Port Barre to the Vermilion River via Bayou Teche, Bayou Fusilier, and the Vermilion River.

1.2.5.7 Operations and Maintenance Dredging of Navigation Channels

Calcasieu River and Pass, Louisiana, published as House Document Number 436, 86th Congress, resulted in authorization by the River and Harbor Act of July 14, 1960 (Public Law 86-646) of the following features: a 42- by 800-foot approach channel from the 42-foot depth in the Gulf of Mexico to the jettied channel; a channel between the jetties varying in depth from 42 feet at the seaward end to 40 feet at the shoreline over a bottom width of 400 feet; a 40- by 400-foot channel from the shoreline (mile 0) to the wharves of the Port of Lake Charles (mile 34.1); enlargement of the existing turning basin at mile 29.6 to a depth of 40 feet; a mooring basin at about mile 3 having dimensions of 40 by 350 by 2,000 feet; extension of the existing channel at a depth of 35 feet over a bottom width of 250 feet from the Port of Lake Charles at mile 34.1 to the vicinity of the bridge on U.S. Highway 90 at mile 36.0, with a 35- by 750- by 1,000-foot turning basin at its upper end; and maintenance of the existing 12- by 200-foot channel from the ship channel to Cameron, Louisiana, via the old channel of the Calcasieu River. The project maintenance is focused in 3 primary reaches. The most gulfward reach from mile 0-5 is maintained with agitation dredging. Two Calcasieu Lake reaches, mile 5-17 and mile 17-22 are typically maintained on an alternating year cycle. The typical quantity removed and disposed for each reach is 2.5 million cubic yards.

The Calcasieu River and Pass Dredged Material Management Plan (DMMP) was approved in December 2010. Existing disposal areas for the continued maintenance of the navigation channels cannot accommodate the volume of material, which would be dredged for channel maintenance. Alternative plans addressed in the DMMP include modification of existing disposal areas, development of new disposal areas, and measures to reduce channel maintenance requirements.

Operations and maintenance (O&M) dredging of navigation channels can provide a source of materials for ecosystem restoration projects. For example, the Calcasieu Dredge Material Management Plan estimates that over 6,000 acres could be created over the next 20 years from the Calcasieu River.

In general, O&M dredge material management plans must be "environmentally acceptable;" however, that does not necessarily mean that the material will be used beneficially. The authorized and funded Louisiana Coastal Area (LCA) Beneficial Use of Dredged Material (BUDMAT) Program also could provides a potential source of funding for beneficial use of dredged material throughout the Louisiana coastal area. Of the nine authorized Federal navigation channels that represent the most significant opportunities for additional beneficial use of dredged material in coastal Louisiana, three are located in the Southwest Coastal area: Calcasieu River and Pass, Mermentau River, and Freshwater Bayou.

Table 1-7: Dredging locations and quantities

CHANNEL / REACH	AVG QUANTITY/ EVENT (cu. yd)	AVG. ANNUAL QUANTITY (cu. yd)	FREQUENCY OF DREDGING	FEDERAL STANDARD (% USED BENEFICIALLY)
Freshwater Bayou - Lock to Gulf	1,057,000	352,333	2 to 4 yrs	100
Freshwater Bayou - inland	2,000,000	133,333	every 15 yrs	n/a
Total	3,057,000	485,666		
Mermentau River – bar & inland*	1,264,000	632,000	1 to 3 yrs	100
Total*	1,264,000	632,000		
Calcasieu – Mile 5 to 14	3,615,000	1,446,000	2 to 3 yrs	0
Calcasieu – Mile 14 to 24.5	5,250,000	2,100,000	2 to 3 yrs	0
Calcasieu – Mile 28 to 36	1,334,000	242,545	3 to 8 yrs	0
Calcasieu - bar	7,547,000	7,547,000	annually	10
Total	17,746,000	11,335,545		
Grand Total	22,067,000	12,453,211		

Note: Based on New Orleans District data from years 1996 through 2007. Extracted from BUDMAT Table 2-6. New Orleans District (CEMVN) Primary Navigation Channels

* The Mermentau River project includes dredging of the Mermentau River from Highway 82 out to the Gulf of Mexico (and also includes Schooner Bayou and Catfish Point Control Structures). The USACE typically dredges Mermentau from LA-82 to the Gulf (approx 6 mile reach) every 2 to 4 years. Most recent dredging took place after Gustav/Ike. However, in light of O&M funding being decreased and low use waterways being funded 50% of their average annual funding, USACE may not dredge the Mermentau again anytime soon. Mermentau falls under the classification of a "low use" waterway (communication with Tracy Falk, USACE Operations Manager for Mermentau).

1.2.6 Community and Regional Growth (Income)

Community and regional growth primarily track population and employment trends that were described in the preceding sections. Table 1-8 shows per capita growth in income since 2000.

Table 1-8: Per capita income

Parish	1990	2000	2010	2012
Calcasieu	$15,489	$22,528	$37,403	$40,892
Cameron	$13,011	$17,935	$31,136	$35,068
Vermilion	$29,729	$18,669	$28,274	$29,729

Source: U.S. Department of Labor Statistics

1.2.7 Tax Revenue and Property Values

Historically, damages from storm surge events have adversely impacted business and industrial activity, agricultural activity, and local employment and income, which then led to commensurate negative impacts to property values and the tax base upon which government revenues rely. As in other developed communities, the presence of high flood risk has reduced property values since the cost of repairing flood damages (whether directly by property owners or through claims made through the National Flood Insurance Program (NFIP) for which annual premiums are charged) increases the long-term cost of property ownership. Measurement of this loss is problematic since the market price of properties capture an extensive array of factors such that the contribution of flood risk cannot be directly ascertained.

Information for 46,860 residential and 4,997 non-residential structures was collected to assist in evaluating the impacts of flood risk under existing and future conditions. Currently, the median depreciated replacement value of housing units for the three-parish study area is $115,684 (in 2012 price prices).

1.2.8 Community Cohesion

Community cohesion is based on the characteristics that keep the members of the group together long enough to establish meaningful interactions, common institutions, and agreed upon ways of behavior. These characteristics include race, education, income, ethnicity, religion, language, and mutual economic and social benefits. The area is comprised of communities with a long history and long-established public and social institutions including places of worship, schools, and community associations.

In 2005 with Hurricane Rita, and again in 2008 with Hurricane Ike, communities in Calcasieu, Cameron, and Vermilion Parishes were inundated by storm surge. In the absence of flood risk reduction measures, local populations were temporarily forced to evacuate and relocate for a significant period, thereby disrupting community cohesion.

1.2.9 Other Social Effects (OSE)

The Hazards and Vulnerability Research Institute at the University of South Carolina created an index that compares the social vulnerability of U.S. counties/parishes to environmental hazards. The variables included in the index are based on previous research which has found that certain characteristics (e.g., poverty, racial/ethnic composition, educational attainment, and proportion over the age of 65) contribute to a community's vulnerability when exposed to hazards. According to the IWR OSE handbook (USACE, 2008), the Social Vulnerability Index (SoVI®)[1] is a valuable tool that can be used in the planning process to identify areas that are socially vulnerable and whose residents may be less able to withstand adverse impacts from hazards.

The SoVI® was computed as a comparative measure of social vulnerability for all counties/parishes in the U.S., with higher scores indicating more social vulnerability than lower scores. Calcasieu Parish has a SoVI® 2006-10 score[2] of -1.21 (0.28 national percentile), Cameron Parish has a SoVI® 2006-10 score of -3.59 (.08 national percentile), and Vermilion Parish has a SoVI® 2006-10 score of -0.04 (0.49 national percentile). Calcasieu Parish is less socially vulnerable than roughly 28 percent of counties/parishes in the U.S., Cameron Parish is less socially vulnerable than about 8 percent of counties/parishes in the U.S., and Vermilion Parish is less socially vulnerable than roughly 49 percent of counties/parishes in the U.S. In comparison, Orleans Parish—notorious for its enduring levels of high poverty—has a SoVI® 2005-09 score of -0.92 with 67 percent of counties/parishes in the nation ranked more socially vulnerable.

Hence, Cameron Parish is the most socially vulnerable to coastal storm damage consequences, Calcasieu Parish is the next most socially vulnerable, and Vermilion Parish is the least socially vulnerable. In comparison, both Cameron and Calcasieu Parishes are more socially vulnerable to coastal storm damage consequences than Orleans Parish.

[1] More information on the methodology and data used to calculate the SoVI® can be found here: http://webra.cas.sc.edu/hvri/products/sovi.aspx

[2] Data can be found here: http://webra.cas.sc.edu/hvri/products/sovi2010_data.aspx

1.2.10 Environmental Justice

The Environmental Justice (EJ) study area contains all Census Tracts and Census block groups located within Calcasieu, Cameron, and Vermilion parishes.

High poverty rates negatively impact the social welfare of residents and undermine the community's ability to provide assistance to residents in times of need. Table 1-9 shows the racial characteristics of the three parishes according to the 2010 U.S. Census. The 2007-2011 American Community Survey (ACS) data indicate that 17 percent of households in Calcasieu Parish, 9 percent in Cameron Parish, and 18 percent in Vermilion Parish fell below the poverty line (Figure 1-4). The 2007-2011 Census American Community Survey data indicate that there are:

- 34 poverty areas and 15 extreme poverty areas (block groups) in Calcasieu Parish (all areas are located in the urban center of Lake Charles)
- 0 poverty areas or extreme poverty areas (block groups) in Cameron Parish
- 18 poverty areas and 3 extreme poverty areas (block groups) in Vermilion Parish (all areas are located in Abbeville and Kaplan).

Table 1-9: Racial characteristics.

Parish	White*	African American*	American Indian / Alaska Native*	Asian*	Hawaiian/ Pacific Islander*	Total	Percent Minority**
Calcasieu	136,514	47,782	898	2,073	93	192,768	29%
Cameron	6,546	119	36	6	0	6,839	4%
Vermilion	46,922	8,286	209	1,160	5	57,999	20%

Source: Census 2010, Census ACS 2007-2011***

According to the 2010 U.S. Census data, there are 39 block groups in Calcasieu Parish and 9 block groups in Vermilion Parish where 50 percent or more of the population identify themselves as part of a minority group. There are no block groups in Cameron Parish where more than 1 percent identifies themselves as part of a minority group (Figure 1-5).

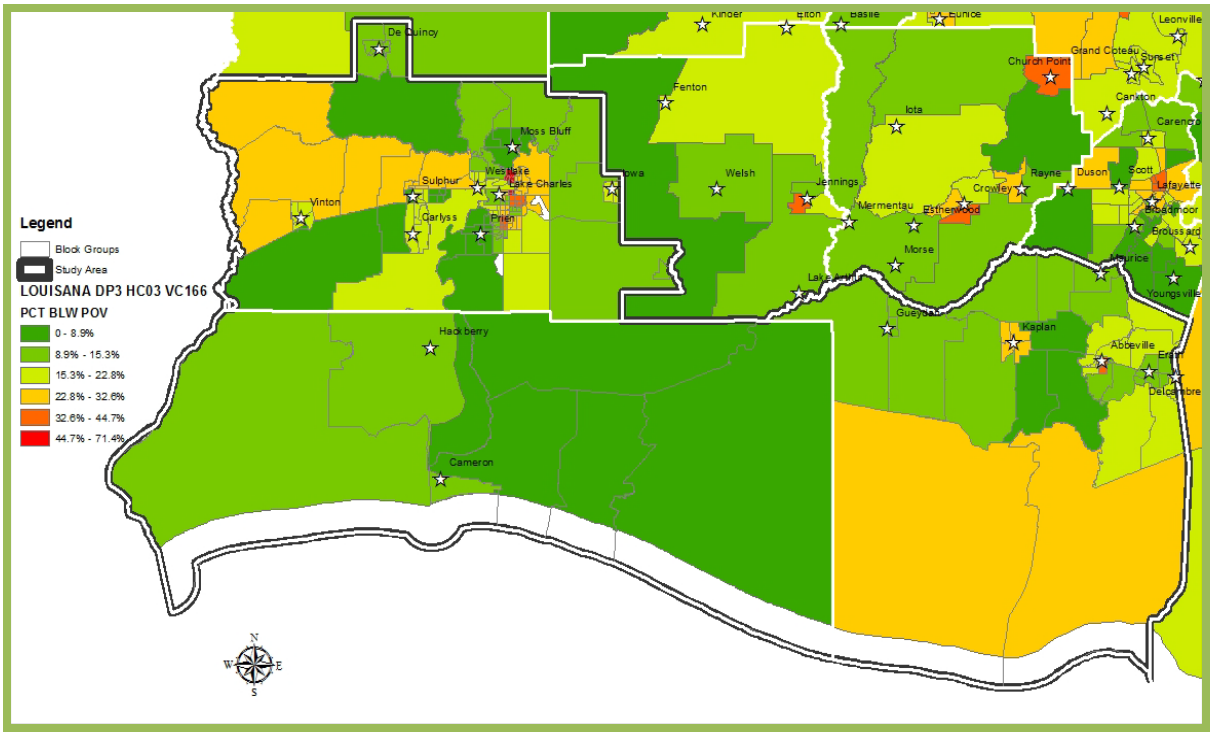

Figure 1-4: Percent population below poverty line, by block group.

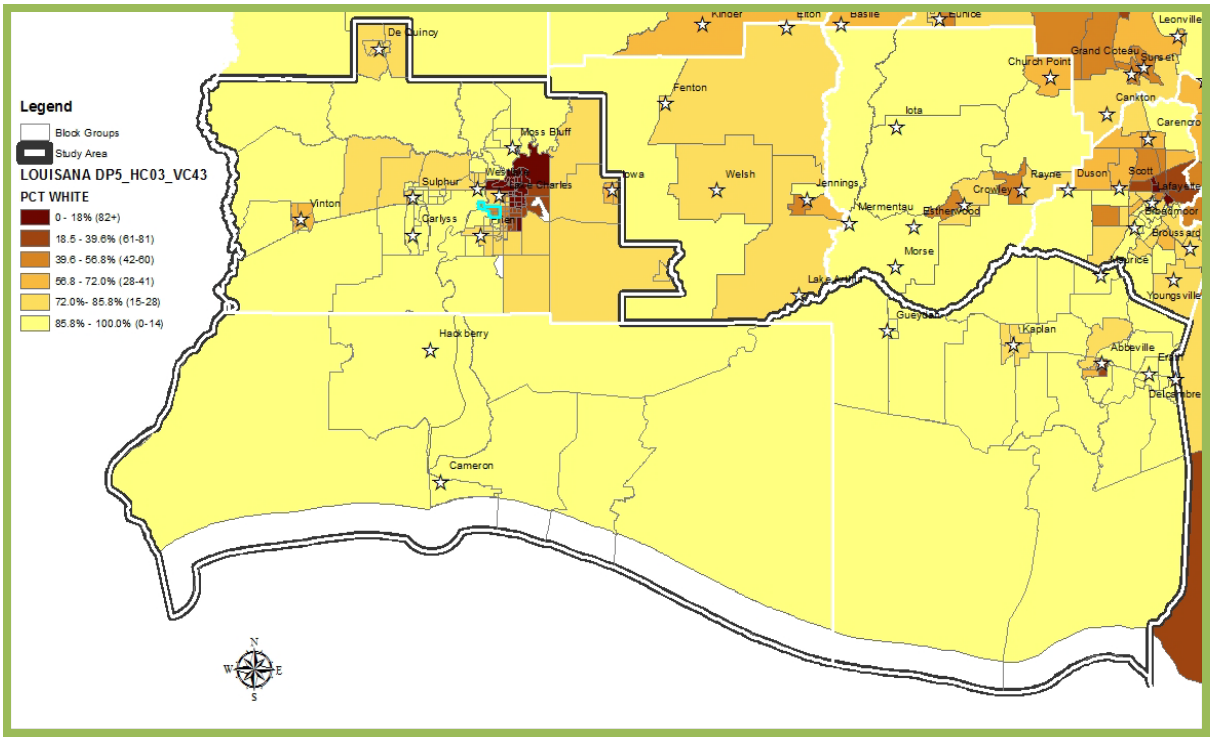

Figure 1-5: Racial majority by block group.

1.3 Water Environment

The two major hydrologic basins in the Chenier Plain are the Mermentau Basin and the Calcasieu-Sabine Basin (LCA, 2004). The Teche-Vermilion Basin is another significant hydrologic basin in the study area. The general location and major features/water bodies in each basin are described below. Figure 1-6 identifies major hydrologic features. For the most part areas below the GIWW are within the coastal zone.

Calcasieu-Sabine Basin

The Calcasieu-Sabine Basin lies in the western portion of the Chenier Plain in Cameron and Calcasieu Parishes. It is bounded to the east by LA-27, to the south by the Gulf of Mexico, and to the west by the Sabine River and Sabine Lake. The Basin is a shallow coastal wetland system with freshwater input at the north end, a north-south flow through Calcasieu and Sabine lakes, and some east-west water movement through the GIWW and interior marsh canals (e.g., North Starks and South Starks canals on the Sabine National Wildlife Refuge). The dominant hydrologic features of the basin are the Calcasieu and Sabine Lakes, which are directly influenced by the Calcasieu, Sabine, and Neches Rivers. Navigation channels include the Sabine-Neches Waterway, Calcasieu River and Pass. Water control structures in the area include the Calcasieu Locks. Managed wetlands are a significant feature of the Calcasieu-Sabine Basin (LADNR 2002).

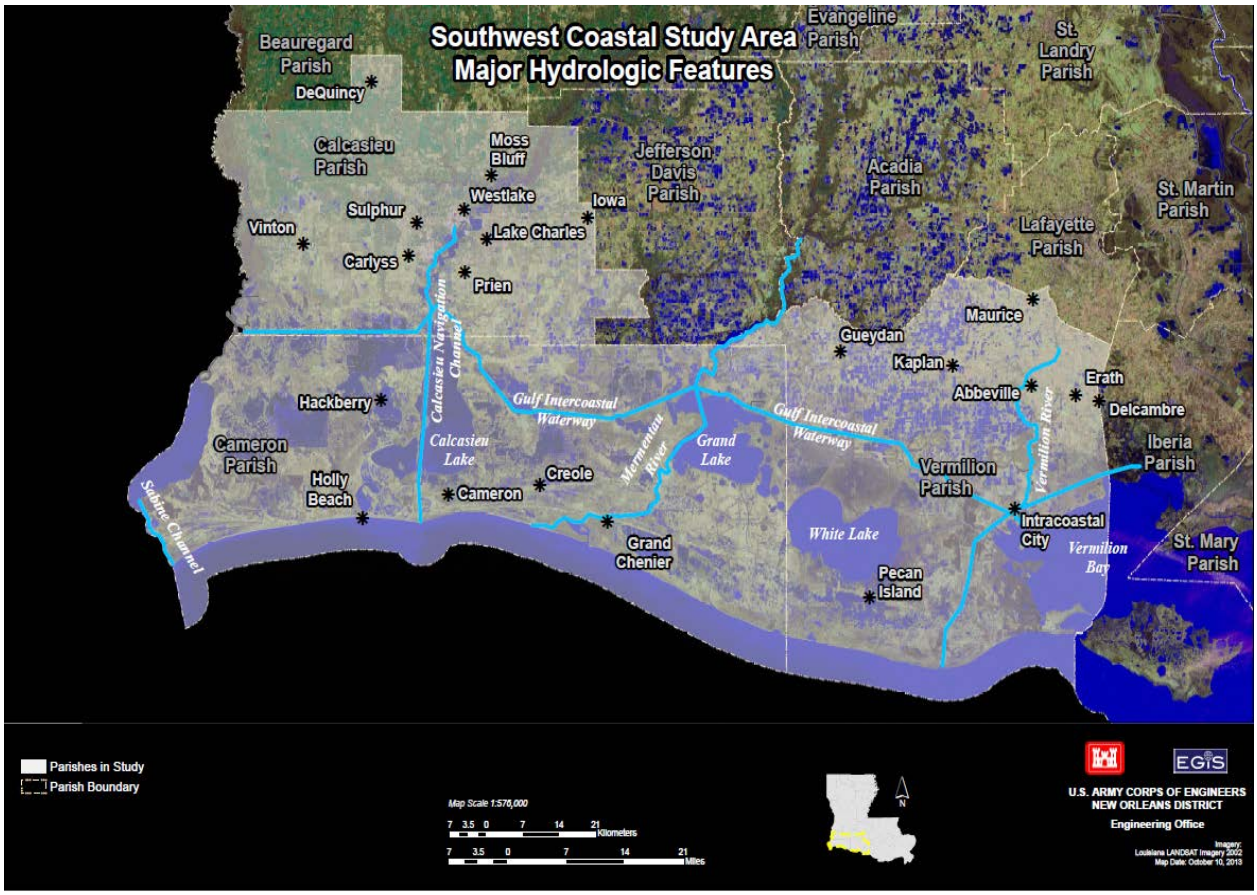

Figure 1-6: Major hydrologic features in the study area.

The Calcasieu drainage basin drainage area north of the point where the river crosses the GIWW is 3,235 square miles. The Sabine drainage basin has a drainage area of 9,760 square miles. The headwaters start in northeastern Texas and the river runs about 150 miles before it meets the Louisiana-Texas state line, then runs to the Gulf. The Toledo Bend Reservoir and Sabine Lake are the major hydrologic features of the Sabine Basin.

The GIWW from the Sabine River to the Calcasieu River is a 125 ft wide x 12 ft deep. Construction of the GIWW significantly altered regional hydrology by connecting the two major ship channels. Prior to the construction of the GIWW, the Calcasieu and Sabine estuaries were mostly distinct and were more influenced by the Calcasieu and Sabine rivers, respectively. The Gum Cove Ridge once separated the Sabine Basin from the Calcasieu Basin, with little water exchange between the basins. Removing the mouth bars and deepening the Calcasieu Ship Channel (CSC) and the Sabine-Neches channels, as well as the GIWW and interior canals bisecting the Gum Cove Ridge, made the region hydrologically indistinct, which caused water flow and salinity patterns of one basin to profoundly affect those patterns of the other basin. In addition to effectively combining the two basins, the GIWW cut off all of the natural bayous and upland sheet flow that historically affected marshes, and channelized more freshwater inflow more directly to the Gulf of Mexico, partially bypassing the marshes.

Mermentau Basin

The Mermentau Basin lies in the eastern portion of the Chenier Plain in Cameron and Vermilion Parishes. The Mermentau River Basin, can be divided into three sub-basins: Upland, Lakes, and Chenier. The Upland Sub-basin covers an area of 3,683 square miles of predominantly agricultural land. The Lakes Sub-basin is delineated by the Freshwater Bayou Canal on the east, the limit of the coastal zone on the north, LA-27 on the west, and LA-82 on the south. LA-82 runs atop and between the Grand Chenier-Pecan Island ridge complex. The Chenier Subbasin lies south of this ridge complex. The dominant hydrologic features of the Mermentau basin are the Grand and White Lakes and the Mermentau River. Navigation channels include the

Mermentau Ship Channel. Various water control structures include the Freshwater Bayou Canal Lock, the Schooner Bayou Canal Structure, and the Catfish Point Control Structure.

Before human-induced hydrologic alterations from navigation channels in the early 1900s, the natural drainage in the Mermentau Basin was dominantly north-south through the Mermentau River, Freshwater Bayou, Bayou Lacassine, and Rollover Bayou. The eastern portion of the basin also drained in an easterly direction through Belle Isle and Schooner bayous. In addition, sheet flow over the marsh occurred between Grand Chenier and Pecan Island ridges, as well as to the west into the Calcasieu/Sabine Basin. Human activities related to wildlife management, navigation improvement, flood control, agriculture, and petrochemical exploitation have dramatically altered the hydrology of the Mermentau Basin. The net effect of these alterations is that drainage through the Lakes Sub-basin is now predominantly east-west and hydrologically isolated from the Chenier Sub-basin. The Lakes Sub-basin now functions more as a freshwater reservoir and less as a low-salinity estuary, its natural form (Gunter and Shell 1958; Morton 1973).

Teche/Vermilion Basin

The Teche/Vermilion Basin extends from Point Chevreuil to Freshwater Bayou Canal and includes East and West Cote Blanche Bays, Vermilion Bay, and the surrounding marshes. Navigation features include the Freshwater Bayou Canal Navigational Channel and the Leland Bowman Lock. The Basin has a drainage area of 3,040 square miles (LCA 2004)

1.3.1 Water Stage Duration and Frequency

Normal astronomical tides in Louisiana are diurnal (one high tide and one low tide per day) and can have a spring range of as much as 2 ft. The mean tidal range is approximately 1.28 ft at Calcasieu Pass and 1.48 ft at Freshwater Canal. Amplitudes are influenced by tides, but are generally controlled by meteorological events. South winds drive water into the marshes.

1.3.1.1 Relative Sea Level Rise

In coastal Louisiana, *relative sea level rise* (RSLR) is the term applied to the difference between the change in eustatic (global) sea level and the change in land elevation. According to IPCC (2007), the global mean sea level rose at an average rate of about 1.7 mm/yr during the 20th Century. Recent climate research has documented global warming during the 20th Century, and has predicted either continued or accelerated global warming for the 21st Century and possibly beyond (IPCC, 2007).

Land elevation change can be positive (accreting) or negative (subsiding). Land elevations decrease due to natural causes, such as compaction and consolidation of Holocene deposits and faulting, and human influences such as sub-surface fluid extraction and drainage for agriculture, flood protection, and development. Forced drainage of wetlands results in lowering of the water table resulting in accelerated compaction and oxidation of organic material. Areas under forced drainage can be found throughout coastal Louisiana and the study area. Land elevations increase as a result of sediment accretion (riverine and littoral sources) and organic deposition from vegetation. Vertical accretion in most of the area, however, is insufficient to offset subsidence, causing an overall decrease in land elevations. The combination of subsidence and eustatic sea level rise is likely to cause the landward movement of marine conditions into estuaries, coastal wetlands, and fringing uplands (Day and Templet, 1989; Reid and Trexler, 1992).

Subsidence Rates - Subsidence rates vary considerably across coastal Louisiana. A coastwide system for quantifying and predicting subsidence on a regional scale has not yet been established. Therefore, subsidence rates are estimated using a combination of benchmark leveling, tide gauge measurements, and radiometric dating of buried marsh horizons.

The subsidence rate for most of the area is considered low, at zero to 1 ft/century; however, the subsidence rates in the Mermentau Basin for Hackberry Ridge, Big Lake, Cameron-Creole, Brown Lake, Hog Island Gully, and Mud Lake watersheds are considered intermediate, at 1.1 – 2 ft per century. Perry Ridge in the Calcasieu/Sabine Basin and Locust Island and Little Prairie in the Mermentau Basin are considered stable (Coast 2050, 2009).

Accretion Rates - Net accretion varies significantly on a local level and over time. Average measurements of accretion across the Louisiana coastal region indicate that current accretion rates are 0.7 to 0.8 cm per year (ERDC/EL TN-10-5). Since there is currently a lack of evidence to support applying a habitat specific accretion rate, a long-term accretion estimate of 0.7 cm per year captures the central tendency of all herbaceous marsh data that have been reviewed for the SW Coastal LA analysis.

1.3.2 Hydrology and Hydraulics

Calcasieu-Sabine Basin

The Calcasieu, Sabine, and Neches rivers are the principal sources of freshwater inflow into this region. The Sabine and Calcasieu rivers follow a north-south gradient, whereas the Neches River flows into Sabine Lake from the northwest. Additionally, an east-west flow occurs between the basins via the GIWW and existing canals on the Sabine National Wildlife Refuge. The hydrology of this area is affected by a complex combination of riverine freshwater inflow, Gulf of Mexico tides, precipitation, and wind effects on water level and directional flow.

The lower Calcasieu River and the CSC have been maintained for navigation since 1874, when the U.S. Army Corps of Engineers (USACE) first constructed a navigation channel through the outer bar of Calcasieu Pass, between Calcasieu Lake and the Gulf of Mexico. Prior to the initial dredging, there was a 3.5-ft-deep shoal at the mouth of the Calcasieu River (War Department 1897). This natural bar acted as a constriction, minimizing saltwater and tidal inflow into the basin. Removal of the channel mouth bar, coupled with subsequent widening and deepening of the CSC, allowed increased saltwater and tidal intrusion into the estuary, resulting in catastrophic marsh loss, tidal export of vast quantities of organic marsh substrate, and an overall shift to more saline habitats in the region (USDA 1994). In addition, the CSC permits the upriver flow of denser, more saline water as a saltwater wedge. In 1968, the USACE completed construction of the Calcasieu River Saltwater Barrier on the Calcasieu River north of the city of Lake Charles. This barrier minimized the flow of the saltwater wedge into the upper reaches of the Calcasieu River to protect agricultural water supplies. The structure consists of a lock and a flood control barrier with five adjustable gates.

Only portions of the CSC are dredged annually. Approximately 75% of the dredged material is placed in upland and offshore disposal sites, but the remaining 25% is used for beneficial means, to create marsh.

The GIWW from the Sabine River to the Calcasieu River is a 125 ft wide x 12 ft deep. Construction of the GIWW significantly altered regional hydrology by connecting the two major ship channels. Prior to the construction of the GIWW, the Calcasieu and Sabine estuaries were mostly distinct and were more influenced by the Calcasieu and Sabine rivers, respectively. The Gum Cove Ridge once separated the Sabine Basin from the Calcasieu Basin, with little water exchange between the basins. Removing the mouth bars and deepening the CSC and the Sabine-Neches channels, as well as the GIWW and interior canals bisecting the Gum Cove Ridge, made the region hydrologically indistinct, which caused water flow and salinity patterns of one basin to profoundly affect those patterns of the other basin. In addition to effectively combining the two basins, the GIWW cut off all of the natural bayous and upland sheet flow that historically affected marshes, and channelized more freshwater inflow more directly to the Gulf of Mexico, partially bypassing the marshes.

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1.3.2.1 Storm Surge

While the study area has periodically experienced localized flooding from excessive rainfall events, the primary cause of the flooding events has been the tidal surges from hurricanes and tropical storms. During the past eight years, the area has been greatly impacted by storm surges associated with three Category 2 or higher hurricanes—Lili, Rita, and Ike, which inundated structures and resulted in billions of dollars in damages to southwest coastal Louisiana. Hurricane surge also causes significant damage to wetlands. Hurricane surge has formed ponds in stable, contiguous marsh areas and expanded existing, small ponds, as well as removed material in degrading marshes (Barras, 2009). Fresh and intermediate marshes appear to be more susceptible to surge impacts, as observed in Barras (2006).

Storms of Record

There have been several floods caused by runoff from heavy rainfall. Some of the major events that occurred over the last thirty years, including Hurricanes Audrey, Lili, Rita and Ike are discussed below.

October 2002. Hurricane Lili (23 September - 3 October) was originally a Category 4 hurricane and first made landfall as a downgraded Category 2 hurricane near Intracoastal City, LA to the west. Wind gusts up to 61 mph were reported near the study area. Rainfall estimates were rather low at 5 inches, due to the rapid forward movement of the storm. Tide levels were 4 to 7 feet above normal, with many areas outside of the study area being flooded. The stage at Harvey Canal at Lapalco reached 9.84 feet National Geodetic Vertical Datum (NGVD) on the 5th.

September 2005. Hurricane Rita (September 24-26) Hurricane Rita first made landfall just west of Johnson's Bayou, LA as a Category 3 hurricane after downgrading from a 180 mph Category 5 hurricane. The coastal communities of southwest Louisiana were all heavily damaged or totally destroyed by the 20-foot surge. The storm surge also completely overtopped the Calcasieu Lock structure. Many low lying areas in Lake Charles also flooded.

September 2008. Hurricane Ike (September 1-14) first made landfall near Galveston, Texas as a Category 2 hurricane with 110 mph winds on September 13, 2008. Although landfall was to the west in Texas, this storm caused extensive flooding due to storm surge created by the large wind field along the south central and southwest coastal parishes of Louisiana. The storm surge also completely overtopped the Calcasieu Lock structure.

1.3.3 Flow and Water Levels

The marsh area of southwest Louisiana extends northward and slightly beyond the GIWW. Rainfall runoff drains from the higher elevations in the north and is trapped in the marsh area to the south due to Chenier ridges that parallel the coast. The natural drainage pattern prior to the construction of the GIWW was for rainfall in the basin to drain through the Mermentau River and empty into the Gulf of Mexico. However, some of that flow is now redistributed to the east and west along the GIWW. The Calcasieu Lock, Catfish Point Control Structure, Leland Bowman Lock, and Schooner Bayou Lock were created to allow for navigation and salinity control.

Land stewardship through hydrologic management and shoreline protection are the mainstays of coastal restoration in the Calcasieu-Sabine basin. Water control structures are operated both passively and actively. Virtually all hydrologic management focuses on controlling salinity and minimizing tidal fluctuations by constructing and operating levees, weirs, and a variety of gated structures. A 1990 inventory of such water control structures identified 174 individual structures in the interior and along the perimeter of the basin (LADNR 2002; Marcantel 1996).

The Cameron-Creole Watershed Project covers approximately 176 square miles in Cameron Parish. The area is bounded by the GIWW on the north; Calcasieu Lake and Calcasieu Pass on the west; LA-27, Little Chenier Ridge, and Creole Canal on the east; and the Gulf of Mexico and Mermentau River on the south. To counter this conversion of marsh to open water, the Cameron-Creole Watershed Project was initiated cooperatively by the Soil Conservation Service [now Natural Resource Conservation Service (NRCS)], Gulf Coast Soil and Water Conservation District, Cameron Parish Police Jury, Cameron Parish Gravity Drainage Districts 3 and

4, the Miami Corporation, and the United States Fish and Wildlife Service (USFWS), Sabine National Wildlife Refuge. The water control structures began operation in 1989 (LADNR 2002).

1.3.4 Water Quality and Salinity

Water quality is influenced by Chenier Plain elevations and geomorphologic processes, surface water budget, land cover and use, and regional weather. The study area consists of low relief topography to the north and estuary to the south, with increasing estuary salinity gradients to the south. The Calcasieu River is connected to the Gulf of Mexico via the CSC and the Mermentau River basin is maintained as a freshwater environment via several water control structures (Rosen and Xu 2011). Hydromodification has occurred as a result of the construction of water control structures, canals, and embankments (Demcheck et al. 2004).

The Sabine River is the dominant influence across most of the basin in moderating gulf salinity and tidal fluctuations. Observations by USFWS personnel reveal that strong and prolonged south and southeast winds result in large volumes of Gulf of Mexico water being pushed into Calcasieu and Sabine lakes, which causes the water level in the marshes to rise (Paille 1996). A similar effect on marsh water level has been observed during periods of low barometric pressure in the region (LADNR 2002; Paille 1996).

The primary saltwater barrier in the Calcasieu Basin is the Calcasieu Lock, located approximately two miles east of the CSC. This sector-gated lock, which opened in 1950, was designed to prevent saltwater intrusion into the Mermentau Basin, and is operated primarily for navigation. During flooding events, the structure is often operated for drainage of the Mermentau Basin to the east.

In general, water quality concerns are related to urbanization to the north, oil and gas activities and saltwater intrusion in the Calcasieu River basin, and agriculture in the Mermentau River basin. Reference the following literature for water quality and salinity studies in the area: Demcheck et al. (2004), Garrison (1997), Waldon (1996), Skrobialowski et al. (2004), Demcheck and Skrobialowski (2003), Macdonald et al. (2011), Rosen and Xu (2011), and Steyer et al. (2008).

Historically (1998-2012) Clean Water Act Section 305(b) assessments of subsegments in the area were evaluated. Long-term average support values reveal that impairments are most common in the uppermost subsegments in the Calcasieu and Teche-Vermillion watersheds. The most commonly suspected causes of impairments were low dissolved oxygen, elevated total suspended solids, mercury, elevated turbidity, nitrate/nitrite, carbofuran, and total phosphorus, while the most commonly suspected sources were unknown, agriculture, natural, atmospheric deposition, flow alteration, urban runoff, and on-site treatment systems. In a recent 305(b) assessment (2012), the most frequently cited suspected causes of impairment included fecal coliform, low dissolved oxygen, turbidity, mercury, total suspended solids, and carbofuran, while most frequently cited suspected sources of impairment include unknown, agriculture, natural, on-site sanitary wastewater treatment systems, atmospheric deposition, and drought-related effects(LDEQ 2013). Information and analysis for water quality monitoring will be developed for the TSP following sampling, analysis, and evaluation of water quality and sediment for the project conducted in later project phases.

1.4 Natural Environment

1.4.1 Sedimentation and Erosion

The study area is divided by the Sabine, Calcasieu, Mermentau, and Vermilion rivers which flow in a north-south direction. These rivers have been highly altered by the placement of locks and dams, dredged channels, manmade outlets to the Gulf, and bisected by the GIWW. These alterations influence the movement of sediment throughout the area. The rivers and interior lakes which they enter (Sabine, Calcasieu, and Grand) act as sediment sinks. Overbank deposition into adjacent marshes is minimal in these low flow rivers. Sediments in the interior lakes can be resuspended and deposited in adjacent marshes during storm events and cold front passages. Extensive hydrologic alterations within the area (levees, channels, roads, locks, control structures, etc.) influence sediment movement throughout. Sediments in the rivers that make it to the coast are deposited at the mouths and generally move westward nourishing the beaches and marshes.

A significant source of sediment is the Atchafalaya River. Sediment travels westward from Atchafalaya Bay and the GIWW and enters the area through tidal exchange at the Gulf and from flooding during storm events. A large percentage of Atchafalaya River sediments are deposited along the Gulf shoreline in the

vicinity of Freshwater Bayou as mudflats while coarser sediments continue westward along the shoreline.

Erosion of material by wave and current action is found throughout. The shorelines of most channels, lakes, and the Gulf are experiencing erosion. Erosion rates are generally highest where the shorelines protrude into the lakes, focusing wave and current action. The Louisiana coast has approximately 350 miles of sandy shoreline along its barrier islands and gulf beaches; however, there are about 30,000 miles of land-water interface along bays, lakes, canals, and streams. Most of these consist of muddy shorelines and bank lines, and virtually all are eroding. In many instances, rims of firmer soil around lakes and bays, and natural levees along streams have eroded away leaving highly organic marsh soils directly exposed to open water wave attack. Examples include Redfish Point, Grassy Point, Umbrella Point, Short Point, and Commissary Point. High rates of Gulf shoreline erosion occur from the vicinity of Rollover Bayou, west to the Mermentau River. Accelerated shoreline loss occurs where erosion has caused Gulf, lake, and channel shorelines to intersect interior water bodies.

1.4.2 Soils, Water Bottoms and Prime and Unique Farmlands

Both hydric and non-hydric soils are found throughout the study area. The area consists generally of forested terrace uplands and Gulf Coast Prairies in the northern portions and Gulf Coast Marsh habitats in the southernmost portions. The major water bottoms throughout include: Lake Charles, Prien Lake, Sabine Lake, Calcasieu Lake, Grand Lake, White Lake and Vermilion Bay. There are numerous smaller lakes such as Sweet Lake, Mud Lake, Black Lake, Big Constance Lake, and Lake Misere. Rivers include the Calcasieu, Sabine, Mermentau and Vermillion Rivers.

1.4.3 Prime and Unique Farmlands

Prime farmlands are present and make up approximately 941,196 acres, or 34.3 percent of the soils; breakdown by parish is as follows: Calcasieu Parish is 479,426 acres, or 51 percent; Cameron Parish is 106,008 acres, or 11 percent; Vermilion Parish is 355,761 acres, or 38 percent. The majority of the Gulf Coast Marshes consists of wetland type soils and shorelines that are prone to frequent flooding and not suitable for agricultural use. Prime farmland is more predominant inland, and outside, of the Gulf Coast Marsh physiographic area. Prime farmland can also be found on natural ridge tops and cheniers (Hackberry loamy fine sand).

Prime farmland soils are best suited for producing food, feed, forage, fiber, and oilseed crops, and possess qualities that are favorable for crop production using only acceptable farming methods (NRCS Soil Survey of Calcasieu Parish, dated June 1988). Several soil types exist that meet those qualities and are identified as prime farmlands. Urban areas, like Lake Charles and Abbeville, as well as industrial areas have excluded some prime farmlands from agricultural use. There is no unique farmland. In their letter dated December 13, 2013, the NRCS determined that the proposed activities would not irreversibly impact prime farmlands and is exempt from the rules and regulations of the FPPA, Subtitle I of Title XV, Section 1539 – 1549 (NRCS letter dated December 13, 2013). Coordination with the NRCS is on-going.

1.4.4 Gulf Coastal Shorelines

Gulf coastal shorelines, located along the northern rim of the Gulf of Mexico, provide essential and critical shelter, nesting, feeding, roosting, cover, nursery, and other habitats and life requirements for fish and wildlife. They also function as the boundary between marine and estuarine ecosystems and provide protection to the estuarine wetlands, bays, and other inland habitats. Coastal shorelines limit storm surge heights, retard saltwater intrusion and limit mechanical erosion by reducing wave energy at the margins of coastal wetlands (Williams et al. 1992).

Coastal shorelines, as well as other coastal landscape features such as shoals, coastal marshes, and forested wetlands, can provide a significant and potentially sustainable buffer from wind wave action and storm surge generated by tropical storms and hurricanes. Rapid deterioration of the barrier coast in costal Louisiana is resulting in a transformation of low-energy, semi-protected bays into high-energy, open marine environments (Stone et al. 2005). Numerical modeling by Stone et al. (2005) demonstrated that physical loss of the barrier system and marsh results in a considerable increase in modeled storm surge levels and wave heights. Geomorphic features such as coastal shorelines and barrier islands, as well as coastal marsh and other wetland land masses can block or channelize flows (Working Group for Post-Hurricane Planning for the Louisiana

Coast 2006). The area's coastal shorelines are experiencing some of the highest land loss rates in the Nation, due to both natural and man-made factors (USACE 2004).

Barrier beach and surf, dune, supratidal and intertidal wetlands and swale habitats have undergone substantial loss due to oil and gas activities (e.g., pipeline construction), construction of navigation channels and jetties, subsidence, sea-level rise, and marine and wind-induced erosion. Recent estimates find Gulf shoreline recession rates vary from 8 feet per year near Cheniere Au Tigre to 52.9 ft per year near the center of the 76,000-acre Rockefeller Wildlife Refuge, located in eastern Cameron and western Vermilion Parishes which borders the Gulf of Mexico for 26.5 miles.

1.4.5 Vegetation Resources

The area consists of open water ponds and lakes, cheniers, Gulf shorelines, and freshwater, intermediate, brackish, and saline marsh. Table 1-11 compares habitat types pre- and post- Hurricane Rita.

Gulf Coast Prairie and Forested Terraced Uplands vegetation includes:

- Swamp, found in low-lying areas typically adjacent to waterways, is dominated by cypress and tupelo-gum.
- Riverine habitats along stream and river bottoms and bottomland forests are comprised of water tupelo, willow, sycamore, cottonwoods, green ash, pecan, elm, cherrybark oak, white oak; these are often interspersed with Chinese tallow. Depending upon the locations, riverine habitats grade into higher elevated and better drained areas comprised of oak-pine forests.
- Oak-pine forest types dominate the better drained areas especially surrounding Lake Charles and Sulfur and include longleaf pine, loblolly pine, slash pine, sweetgum, elm, southern red oak, water oak, black gum and Chinese tallow.
- Pasture and rangelands with mixtures of perennial grasses and legumes (e.g., bermundagrass, Pensacola bahiagrass, tall fescue, and white clover) comprise the majority of the outlying areas surrounding Abbeville, Erath, and Delcambre.

The Gulf Coast Marsh consists of gulf shorelines with barrier shorelines, dunes and back barrier vegetated areas; cheniers; freshwater, intermediate, brackish, and saline marsh; interspersed with bayous, lakes, ponds and other waters of which some may include submerged vegetation (SAVs). Vegetation typically follows the salinity gradient (O'Neil 1949; Chabreck et al. 1972; Gosselink et al. 1979; Visser et al. (2000):

- Gulf shorelines vegetation includes sea-beach orach, sea rocket, pigweed, beach tea, salt grass, seaside heliotrope, common and sea purslane, marsh-hay cordgrass, and coastal dropseed (LCA 2004, Gosselink et al. 1979).
- Cheniers are live oak-hackberry forests with live oak and hackberry the dominant tree canopy species with other typical species including swamp red maple, toothache tree, green ash, American elm. Although this forest type is the typical habitat, some areas may be scrub thicket or grasslands (source: http://dnr.louisiana.gov/assets/docs/coastal/227-009-001NG-Chenier-Rpt-DNR.pdf; accessed September 16, 2013; LADNR 2009).
- Marsh types: Visser et al (2000), expanding on previous studies by Penfound and Hathaway (1938) and Chabreck (1970), classified freshwater marsh in the Chenier Plain as a combination of maidencane and bulltongue arrowhead; intermediate marsh as sawgrass, saltmeadow cordgrass, and California bulrush; brackish marsh as saltmeadow cordgrass, chairmaker's bulrush, and sturdy bulrush; and saline marsh as smooth cordgrass, needlegrass rush, and saltgrass.
- SAVs: wild celery, duckweed, pickerelweed, sago pondweed, southern naiad.

Invasive plants include water hyacinth, alligatorweed, hydrilla, common salvinia, giant salvinia, Chinese tallow, Chinese privet, Cogon grass, Johnsongrass, Japanese privet, Japanese honeysuckle, common ragweed, rescuegrass, sticky Chickweek, purple nutsedge, mimosa tree (personal communication Cindy Steyer, NRCS on September 20, 2013). These invasive species compete with native flora for resources such as nutrients and light, community structure and composition, and ecosystem processes. Water hyacinth, common salvinia,

giant salvinia, and hydrilla all limit the amount of light penetrating the water column which effects plankton biomass production. Alligatorweed, Chinese tallow and Chinese privet are of minimal wildlife value and can proliferate until nearly monocultural stands exist, limiting food available for wildlife.

Table 1-10: Habitat types by basin in acres. Square kilometers (km²) in parentheses.

Habitat Type	Calcasieu/Sabine Basin		Mermentau Basin		Teche/Vermilion Basin	
	2004	2005	2004	2005	2004	2005
Forested Wetlands	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	46,080 (186.5)	46,080 (186.5)
Other Land	46,080 (186.5)	45,4400 (183.9)	51,840 (209.8)	38,400 (155.4)	21,760 (88.1)	20,480 (82.9)
Freshwater Marsh	96,000 (388.5)	89,600 (362.6)	281,601 (1,139.6)	230,401 (932.4)	33,280 (134.68)	32,640 (132.1)
Intermediate Marsh	177,520 (694.1)	163,200 (660.5)	119,680 (484.3)	103,040 (417.0)	122,880 (497.3)	122,600 (492.1)
Brackish Marsh	81,280 (328.9)	78,720 (318.6)	60,800 (246.1)	55,680 (225.3)	82,560 (334.1)	80,640 (326.3)
Saline Marsh	8,960 (36.3)	8,960 (36.3)	26,240 (106.3)	25,600 (103.6)	5,120 (20.7)	5,120 (20.7)
Water	184,961 (748.5)	202,881 (821.0)	202,241 (818.4)	289,281 (1,170.7)	348,162 (1,408.9)	353,281 (1,429.7)
Totals	588,803 (2,382.8)	588,803 (2,382.8)	742,403 (3,004.4)	742,403 (3,004.4)	659,843 (2,670.3)	659,843 (2,670.3)

Land Loss

The process for wetland loss can start with the result of gradual decline of marsh vegetation due to inundation and saltwater intrusion eventually leading to complete loss of marsh vegetation or the result of storm surge events. As marsh vegetation is lost, underlying soils are more susceptible to erosion and are typically lost as well, leading to deeper water and precluding marsh regeneration. Significant accretion of sediments is then required in order for marsh habitat to reestablish. Perhaps the most serious and complex problem in the study area is the rate of land and habitat loss. The Louisiana coastal plain contains one of the largest expanses of coastal wetlands in the contiguous United States and accounts for 90 percent of the total coastal marsh loss in the nation (USACE 2004).

The effects of recent hurricanes have accelerated marsh loss. Table 1-11 includes estimates of wetland loss attributed to the major hurricanes of 2004 to 2008 in the Chenier Plain and throughout coastal Louisiana.

Table 1-11: Wetland loss estimates (km²) following hurricanes Katrina and Rita (2005) and Gustav and Ike (2008) by geographic province (Barras 2009).

Period	Storms	Chenier Plain	Marginal Delta Plain	Delta Plain	Coastal Louisiana
2004-2006	Katrina + Rita	-72,154 (-292)	-642 (-2.6)	-56,834 (-230)	-129,730 (-525)
2006-2008	Gustav + Ike	-34,347 (-139)	-14,579 (-59)	-30,641 (-124)	-79,815 (-323)
2004-2008	All storms	-106,750 (-432)	-15,320 (-62)	-87,475 (-354)	-209,545 (-848)

1.4.6 Rare, Unique, and Imperiled Vegetative Communities

The following rare, unique, and imperiled communities, documented by the Louisiana Natural Heritage Program, are important in that they contribute to the diversity and stability of the coastal ecosystem. In the

future without action, these rare, unique, and imperiled vegetative communities are expected to continue disappearing. For example, without action, saltwater intrusion and drainage problems would continue, resulting in the conversion of freshwater marsh to intermediate and brackish marsh. Table 1-12 displays information from the LNHP database identifying rare, unique or imperiled vegetative communities (LDWF 2013).

Coastal Live Oak-Hackberry Forest (chenier maritime forest): Also known as chenier maritime forest, this natural community formed on abandoned beach ridges primarily in southwest Louisiana. Composed primarily of fine sandy loams interbedded with sand and shell debris, these ridges range in height from 4 to 5 ft above sea level. Live oak and hackberry are the dominant canopy species. Other common species include red maple, sweet gum, water oak, green ash, and American elm.

Chenier forests have historically been subject to human disturbance. It is the only high ground in the landscape and therefore is used for development, highways, access roads, infrastructures, oil and gas production, and agriculture. In a study conducted by Providence Engineering and funded by the LDNR on the cheniers and natural ridges, approximately 11 percent of the cheniers studied were undeveloped (Cheniers and Natural Ridges Report, 2009). Of the original 100,000 to 500,000 acres in Louisiana, only 2,000 to 10,000 acres remain.

Coastal Dune Grassland: Coastal dune grasslands occur on beach dunes and elevated backshore areas above intertidal beaches. Louisiana's coastal dunes are poorly developed because of the high frequency of overwash associated with hurricanes and storms, and a limited amount of eolian-transported sand. Vegetative cover ranges from sparse to fairly dense and is dominated by salt spray tolerant grasses. Coastal dune grasslands are estimated to have occupied less than 2,000 acres in pre-settlement times, and 50 to 75 percent was thought to remain prior to the 2005 hurricanes. Some of the most extensive examples of coastal dune grasslands in Louisiana occur in the Chenier Plain.

Coastal Prairie: The Coastal Prairie can be divided into two main types, upland dry to mesic prairies at the northern end of its range, and marsh fringing prairies on "islands" or "ridges" in the marsh at the southern end of its range. The soil conditions and frequent burning from lightning strikes prevented invasion by woody trees and shrubs and maintained the prairie vegetation. Coastal prairie vegetation is extremely diverse and dominated by grasses. Remnant Louisiana coastal prairies, once covering an estimated 2.5 million acres, have been reduced to less than 1 percent of the original extent. Some of the larger prairie remnants are marsh fringing, wet prairies found in Vermilion and Cameron Parishes.

Freshwater Marsh: Freshwater marsh is generally located adjacent to intermediate marsh along the northern extent of the coastal marshes. Salinities are usually less than 2 parts per thousand (ppt) and normally average about 0.5-1 ppt. Freshwater marsh has the greatest plant diversity of any of the marsh types. Although the freshwater marshes, as previously described, compose a large amount of the entire coastal marsh acreage, the Louisiana Natural Heritage Program ranks this community as imperiled because it has undergone the largest reduction in acreage of any of the marsh types over the past 20 years due to saltwater intrusion. Some of the largest contiguous tracts of freshwater marsh in Louisiana occur in Vermilion and Cameron Parishes.

Table 1-12: Louisiana Natural Heritage Program rare, unique or imperiled vegetative communities.

Vegetative Communities	Basins or Parish
Submergent Vascular Vegetation (Marine & Estuarine)	Waters of northern Gulf of Mexico, Vermilion-Teche, Mermentau, Calcasieu and Sabine.
Salt Marsh	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Brackish Marsh	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Intermediate Marsh	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Coastal Prairie	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Flatwoods Ponds	Calcasieu Parish
Western Hillside Seepage Bogs	Calcasieu and Sabine
Scrub/Shrub Swamp	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Cypress Swamp	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Bottomland Hardwood Forest	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Batture	Vermilion-Teche

Table 1-12: Louisiana Natural Heritage Program rare, unique or imperiled vegetative communities.

Vegetative Communities	Basins or Parish
Live Oak Natural Levee Forest	Vermilion-Teche
Bayhead Swamp/Forested Seep	Calcasieu Parish
Pine Flatwoods	Calcasieu Parish
Western Longleaf Pine Savannah	Calcasieu Parish
Small Stream Forest	Calcasieu Parish
Coastal Dune Grassland	Mermentau, Calcasieu, Sabine
Coastal Dune Shrub Thicket	Mermentau, Calcasieu, Sabine
Coastal Live Oak-Hackberry Forest	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Western Upland Longleaf Pine Forest	Calcasieu Parish
Western Xeric Sandhill Woodland	Calcasieu Parish
source: http://www.wlf.louisiana.gov/wildlife/louisiana-natural-heritage-program	

1.4.7 Wildlife Resources

Coastal and especially estuarine wildlife is taxonomically diverse with distributions shaped by landforms, climate, salinity, tides, vegetation, other animals and human activities (Day et al. 1989) shows the status, functions of interest, trends, and projections from 1985 through 2050 for avifauna, furbearers, game mammals, and reptiles as adapted from the Coast 2050 report by LCWCRTF & WCRA (1999).

Birds

Area estuarine wetlands, cheniers, and barrier habitats have historically provided many different species of birds and other wildlife with shelter, nesting, feeding, roosting, cover, nursery, and other life requirements. These habitats provide neotropical migrants with essential staging and stopover habitat (after Stoffer and Zoller 2004, Zoller 2004). Cheniers attract thousands of trans-Gulf migrant birds during their peak migratory months of April to May and August through October. The majority of these birds fly to and from parts of Mexico, and the cheniers offer the birds an important stop-over on their migration. Millions of ducks and geese also use the area from September through February. Over 300 species of birds have been recorded in the area, making this region a popular destination for visiting birders, wildlife photographers, and hunters. However, climate and seasonal availability of resources affect the ways estuaries are used by birds and other wildlife (Day et al. 1989). Vegetated habitats within urban and suburban areas, such as BLH and swamp habitats along streams, lakes, and other waterways, provide critical breeding bird habitats (Wakeley and Roberts 1996).

Among the several sources documenting Louisiana birds, Lowery (1974) and the US Forest Service (source: http://www.fs.fed.us/land/pubs/ecoregions/ch21.html accessed September 20, 2013) indicate the area supports shorebirds (e.g., piping plover, sandpipers, gulls, stilts, skimmers, and oystercatchers), ducks and geese (e.g., mottled duck, mallard, fulvous tree-duck, pintail, teal, wood duck, scaup, mergansers, and Canada goose); herons, egrets, ibis and cormorants; hawks and owls (e.g., bald eagle, osprey, and barred owl); belted kingfisher; woodpeckers and sapsuckers; marsh birds (e.g., rails and gallinules); and various songbirds (e.g., wrens, flycatchers, swallows, warblers, and vireos). Waterfowl, seabirds, coots, and rail populations are stable within the Calcasieu-Sabine and Mermentau basins (LCWCRTF & WCRA 1999).

The bald eagle and brown pelican have increased populations resulting in de-listing as endangered species. Colonial nesting waterbird rookeries (e.g., herons, egrets, ibis, night-herons, and roseate spoonbills) are found throughout and generally show stable or increasing populations (LCWCRTF & WCRA 1999).

Habitat loss and fragmentation is among the most pervasive threats to the conservation of biological diversity (Rosenberg et al. 1997). Area BLH, swamp, and other riverine habitats provide travel corridors for birds and other wildlife connecting populations which have been effected by habitat loss and fragmentation. The greatest threat to birds throughout not only the area, but the entire North American continent, is habitat loss (American Bird Conservancy 2009).

Mammals

Most estuarine mammals show distributions or behaviors that are related to salinity patterns (Day et al. 1989). Large herbivores and carnivores include manatee, coyote, red wolf, ringtail, and river otter; smaller herbivores

include swamp rabbit, fulvous harvest mouse, eastern wood rat, and nutria (source: http://www.fs.fed.us/land/pubs/ecoregions/ch21.html accessed September 20, 2013). Populations of furbearers (nutria, muskrat, mink, otter, and raccoon) and game mammals (rabbits, squirrels, and white-tailed deer) have been stable or increasing (LCWCRTF & WCRA 1999).

Prior to the introduction of nutria to Louisiana in 1930s (USGS 2000, Baroch et al. 2002), no invasive wildlife species were known to be present. A substantial population increase of nutria is attributed to the decline in the price of pelts in 1989 (USGS 2000, Baroch et al. 2002). Areas of extensive nutria damage, or "eat outs," alter the composition and habitat type of wetland communities (USGS, 2000). Aerial surveys estimated 80,000 acres of marsh in the State of Louisiana were damaged by nutria (Keddy et al. 2007).

Amphibians and Reptiles

Common species of amphibians and reptiles include the Gulf coast salt marsh snake, Gulf coast toad, pig frog, American alligator, diamondback terrapin, Mediterranean gecko, and Texas horned lizard (source: http://www.fs.fed.us/land/pubs/ecoregions/ch21.html accessed September 20, 2013). The LADNR (2009) observed the following reptiles within the cheniers: the American alligator; turtles (e.g., musk turtle, pond slider, and red-eared slider); snakes (e.g., plain-bellied water snake, banded water snake). Various lizards, and skinks (LADNR 2009). Little is known about amphibian or reptile populations with the exception of the American alligator whose population continues to remain stable (source: accessed on September 19, 2013; http://www.wlf.louisiana.gov/general-alligator-information)

1.4.8 Aquatic and Fisheries Resources

Plankton Resources

Plankton communities serve several important roles in the coastal waters of Louisiana. Bacterioplankton are primarily decomposers; phytoplankton are the primary producers of the water column, and form the base of the estuarine food web; zooplankton provide the trophic link between the phytoplankton and the intermediate level consumers such as aquatic invertebrates, larval fish, and smaller forage fish species (Day et al. 1989; Thompson and Forman 1987). Biological factors such as predation by nekton and ctenophores, duration of the larval stages of meroplankton, and changes in the aquatic environment brought by the zooplankton populations themselves are important biological factors in the regulation of zooplankton densities (Bouchard and Turner 1976; Conner and Day 1987). Bouchard and Turner (1976) found that salinity largely influenced the distribution of zooplankton. Gillespie (1978) found spring zooplankton peaks were related to temperature. Conner and Day (1987) identified the following factors affecting zooplankton populations: tidal flushing, inflow of freshwater carrying organic detritus, river discharge, water depth, tidal changes, turbidity, and dissolved oxygen.

Benthic Resources

Gosselink et al. (1979) provide an extensive overview of benthic resources in the area. The bottom estuarine substrate or benthic zone regulates or modifies most physical, chemical, geological, and biological processes throughout the entire estuarine system via what is called a benthic effect (Day et al. 1989). Benthic habitats do not have a static structure; rather, they provide a residence for many sessile, burrowing, crawling, and even swimming organisms Benthic animals are directly or indirectly involved in most physical and chemical processes that occur in estuaries and trophic relationships that occur in aquatic ecosystems (Day et al. 1989). Oysters and mussels from the epibenthic community provide commercial and recreational fisheries and create oyster reef habitats used by many marine and estuarine organisms. Estuarine benthic organisms include: macrobenthic (e.g., molluscs, worms, large crustaceans); microbenthic (e.g., protozoa); and meiobenthic (e.g., microscopic worms and crustaceans) groups (Day et al. 1989). Primary consumer groups of the benthic habitat include: bacteria and fungi, microalgae, meiofauna, and microfauna (Mitsch and Gosselink 2000). A major link in the aquatic food web between plants and predators is formed by the conversion of plant material (formed in primary production) by benthic detritivores and herbivores to animal tissue (Cole 1975). The salt marsh is a major producer of detritus for both the salt marsh system and the adjacent estuary (Mitsch and Gosselink 2000). In some cases, exported marsh detritus is more important than the phytoplankton based production to the estuary. Detritus export and the shelter found along marsh edges make salt marshes important nursery areas for many commercially important fish and shellfish.

The American oyster is a keystone estuarine species and has been identified as an ecosystem engineer (Dame 1996). Oyster reefs provide major structural components of estuaries and support more animal life than any other portion of the sea bottom (Bahr and Lanier 1981; Meyer and Townsend 2000; Nelson et al. 2004; Tolley and Volety 2005; Tolley et al. 2005; Boudreaux et al. 2006). The total number and densities of fish, invertebrate and algal species greatly increase in areas containing oyster reefs (Bahr & Lanier 1981). More than 300 marine invertebrate species may occupy an oyster reef at one time (Wells 1961). In addition to increasing species richness, the three-dimensional structure of the reef provides other services such as stabilizing and buffering shorelines from high wave energy (Smithsonian 2001). Because oysters are sessile and pump water through their bodies, they are recognized as good ecosystem monitors. Changes in ecosystem health can be noted over time scales varying from hours to years. Because oysters are continually submersed in environmental conditions, they actively contribute to water quality assessments (Smithsonian 2001). In addition, the chemistry of their shell can provide information on global changes in the environment (Surge et al. 2003). Accordingly, oysters have been used as monitors and indicators of stress in marine ecosystems. Figure 1-7 shows the location of the oyster reefs Sabine Lake. Calcasieu Lake has been designated by the LDWF as a Public Oyster Tonging Area. More information on oysters including locations of oyster reefs in other areas can be found at the Louisiana Department of Wildlife and fisheries website (http://www.wlf.louisiana.gov/fishing/oyster-program). The Louisiana portion of Sabine Lake has approximately 34,067 water bottom acres. This area was cleared by LDHH in March of 2011 for harvesting, but LDWF has not opened a season on this area at this time.

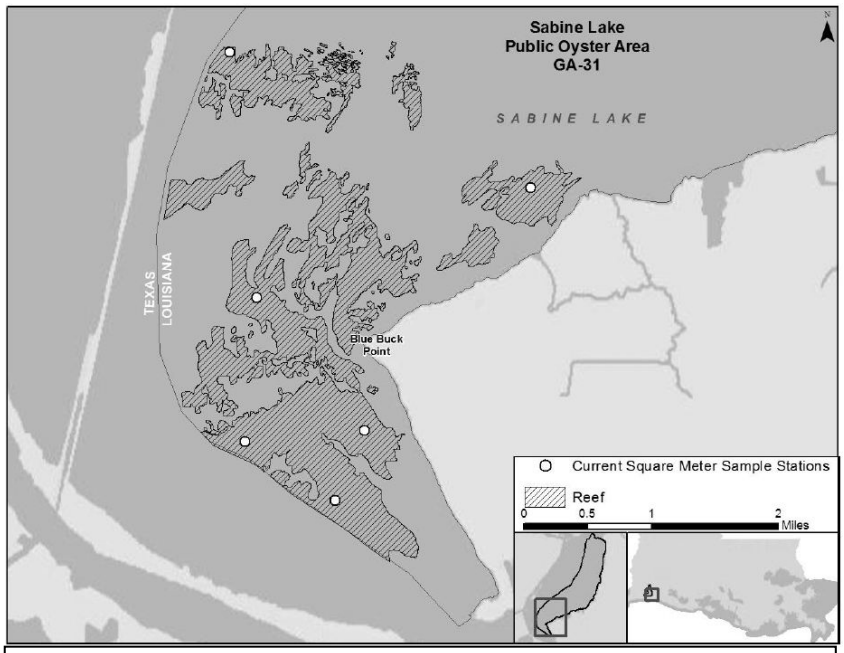

Figure 1-7. Oyster reefs in Sabine Lake.

Fisheries Resources

The area contains a variety of aquatic habitats, including rivers, bayous, canals, lakes, ponds, shallow open water areas, the Gulf of Mexico, and estuarine marsh and embayments. Salinity and habitat structure (SAV, marsh, tidal creeks, deep water, oyster reefs, and benthic substrate) are the primary drivers that affect the distribution of fish and macrocrustaceans throughout the area with three general types: freshwater resident, estuarine resident, and transient marine species. Freshwater species, some of which may tolerate low salinities, generally live in the freshwater portions of the more interior and northern-most regions of the area. Resident species are generally smaller and do not commonly migrate very far. Marine transient species spend a portion of their life cycle in the estuary, generally spawning offshore or in high-salinity bays, and use coastal marshes as nursery areas (Herke 1971, 1995). Species typically found in freshwater areas include: spotted gar, bowfin, largemouth bass, channel catfish, crappie, and gizzard shad. Estuarine-dependent species typically include red and black drum, spotted seatrout, Gulf menhaden, and southern flounder. Typical marine species include king and Spanish mackerel, and cobia.

1.4.9 Essential Fish Habitat (EFH)

Figures 1-8, 1-9, 1-10 and 1-11 display EFH for coastal migratory pelagics (king mackerel, Spanish mackerel and cobia); shrimp (brown, white and pink shrimp); red drum; and stone crab, respectively within the area (source: http://www.habitat.noaa.gov/protection/efh/newInv/index.html). Table 1-14 list the EFH for life stages of species

Figure 1-8: Coastal migratory pelagic EFH
(source: http://www.habitat.noaa.gov/protection/efh/newInv/index.html)

Figure 1-9: Shrimp EFH (source: http://www.habitat.noaa.gov/protection/efh/newInv/index.html)

Figure 1-10: Red drum EFH (source: http://www.habitat.noaa.gov/protection/efh/newInv/index.html)

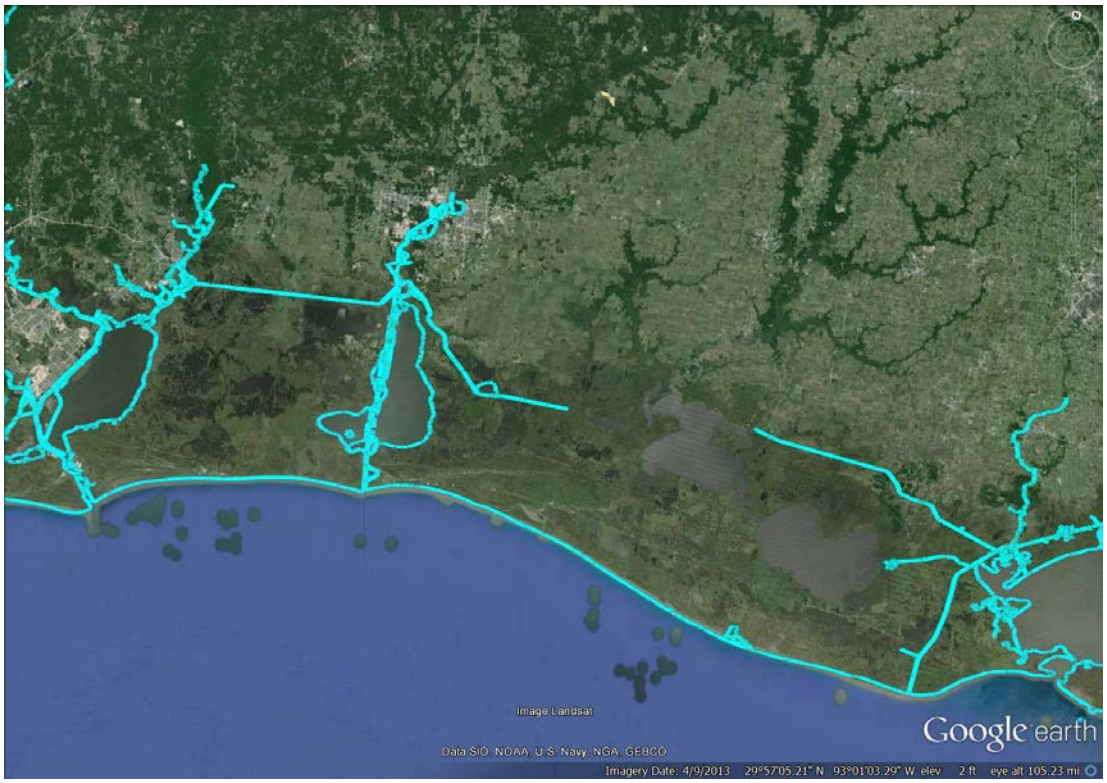

Figure 1-11: Stone crab EFH (source: http://www.habitat.noaa.gov/protection/efh/newInv/index.html)

Table 1-13: EFH for life stages of species in the area (source: http://www.habitat.noaa.gov/protection/efh/newInv/index.html)

Species	Life Stage	EFH
Brown shrimp	eggs	Gulf of Mexico < 110 m, demersal
	larvae	Gulf of Mexico < 110 m, planktonic
	postlarvae/ juvenile	marsh edge, SAV, tidal creeks, inner marsh
	subadult	estuarine mud bottoms, marsh edge
	adult	Gulf of Mexico <110m, silt sand, muddy sand
White shrimp	eggs	Gulf of Mexico < 40 m, demersal
	larvae	Gulf of Mexico < 40 m, planktonic
	postlarvae/ juvenile,	marsh edge, SAV, marsh ponds, inner marsh, oyster reefs
	subadult	marsh edge, SAV, marsh ponds, inner marsh, oyster reefs
	adult	Gulf of Mexico < 33 m, silt, soft mud
Red drum	eggs, larvae	Gulf of Mexico planktonic
	postlarvae/juvenile	SAV, estuarine mud bottoms, marsh/water interface
	subadult	estuarine mud bottoms, oyster reefs
	adult	(Marine and Estuarine systems) Gulf of Mexico & estuarine mud bottoms, oyster reefs
Spanish mackerel	larvae	offshore <50 m
	juvenile	offshore, beach, estuarine
	adult	marine pelagic
King Mackerel	juvenile/adults	marine pelagic
Cobia	eggs	marine pelagic
	larvae	estuarine & shelf
	postlarvae/juvenile	coastal & shelf

Table 1-13: EFH for life stages of species in the area (source: http://www.habitat.noaa.gov/protection/efh/newInv/index.html)

Species	Life Stage	EFH
	adults	coastal & shelf

1.4.10 Threatened and Endangered Species

There are 11 threatened or endangered species and one candidate species known or believed to occur in the area (Table 1-14) as well as critical wintering habitat for the piping plover. There are no threatened or endangered plants in the area (informal coordination based on personal communication with Brigette Firmin, USFWS, September 20, 2013).

Table 1-14: Federally listed and candidate species within the area.

Species	Acadia Parish	Calcasieu Parish	Cameron Parish	Vermilion Parish
*Sprague's Pipit (*Anthus spragueii*)	Candidate	Candidate	Candidate	Candidate
Red-cockaded woodpecker (*Picoides borealis*)		Endangered		
Piping plover (*Charadrius melodus*)			Threatened Critical habitat	Threatened Critical habitat
Red knot (*Calidris canutus*)			Threatened	Threatened
**Whooping crane (*Grus americana*)				Threatened
West Indian manatee (*Trichechus manatus*)			Endangered	Endangered
Gulf sturgeon (*Acipenser oxyrinchus desotoi*)			Threatened	Threatened
Green sea turtle (*Chelonia mydas*)			Threatened	Threatened
Kemp's (Atlantic) ridley sea turtle (*Lepidochelys kempi*)			Endangered	Endangered
Leatherback sea turtle (*Dermochelys coriacea*)			Endangered	Endangered
Hawksbill Sea turtle *(Eretmochelys imbricate*)			Endangered	Endangered
Loggerhead sea turtle (*Caretta caretta*)			Endangered Critical habitat	Endangered Critical habitat

* Candidate species are those taxa for which the Service has on file sufficient information regarding biological vulnerability and threat(s) to support issuance of a proposal to list.
**This is a nonessential population which is considered "threatened." However, Section 7 of the Endangered Species Act consultation regulations do not apply.

Piping plovers winter in Louisiana but do not nest on Louisiana's coast. Critical wintering habitat encompasses 24,950 acres along 342.5 miles of shoreline, which is most of the coast of Louisiana. Critical habitat is presented in Figure 1-12. Piping plovers arrive from their northern breeding grounds as early as late July and may be present in designated critical wintering habitat for 8 to 10 months of the year.

Loggerhead Critical Habitat (*Sargassum* habitat) exists in the southernmost (offshore) portion of the SWC project area. This critical habitat expands the entire length of the project (west to east) with the closest points ranging from approximately 4 miles to 9 miles offshore.

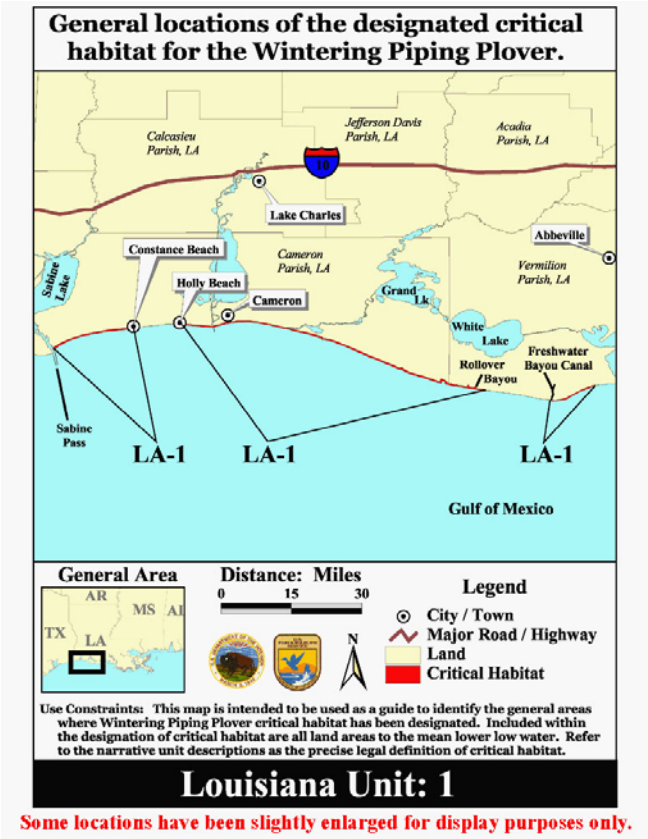

Figure 1-12: Designated critical habitat for wintering piping plover

(source: http://www.fws.gov/plover/finalchmaps/Plover_LA_1.jpg accessed September 20, 2013).

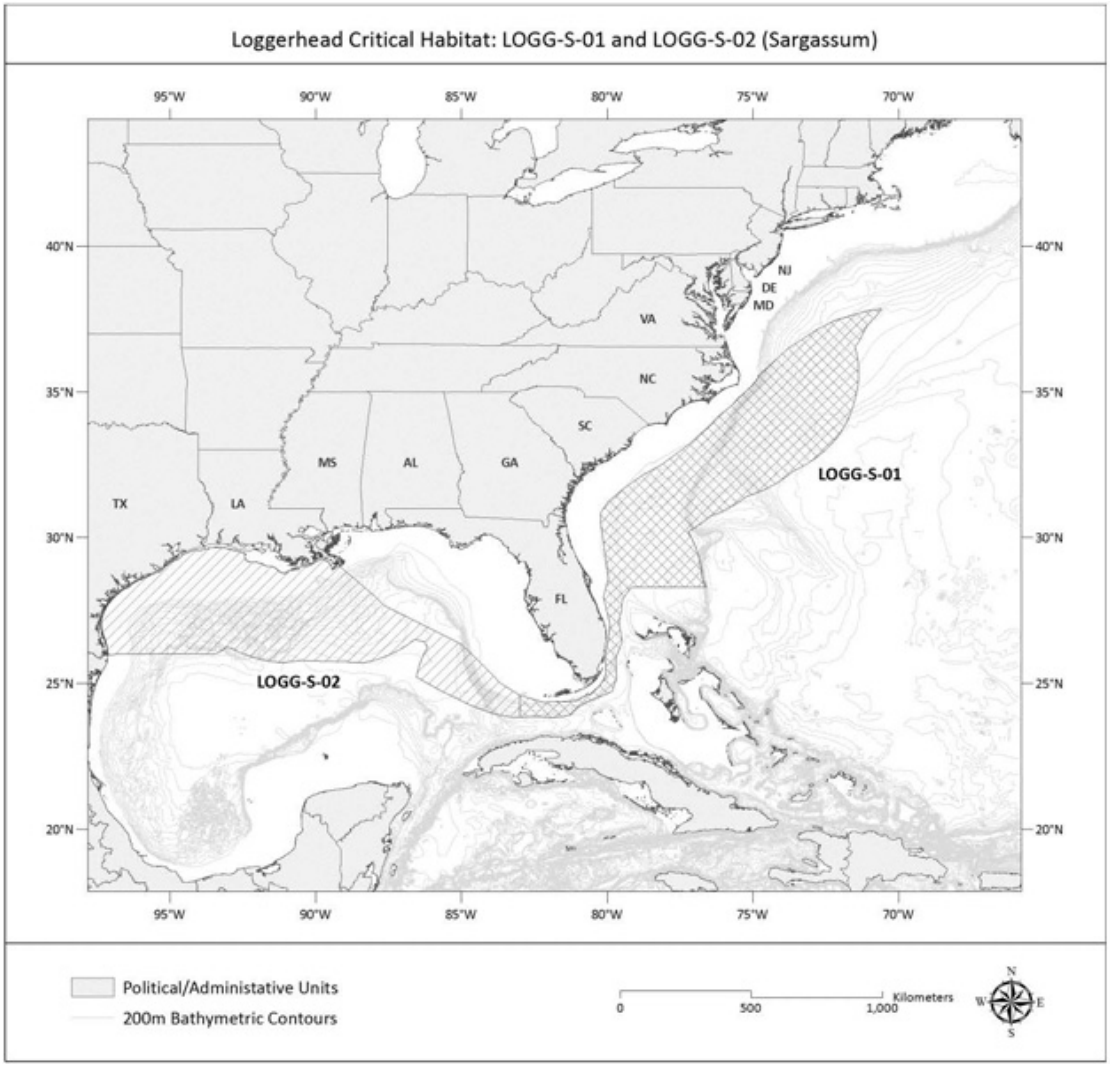

Figure 1-13 Loggerhead Critical Habitat

1.4.11 Historic and Cultural Resources

The cultural history of coastal southwest Louisiana is a very rich one, going back some 10,000 years or more. The general chronological sequence can be summarized as follows: Paleoindian (11,500 - 6,000 B.C.), Archaic (6,000 - 1,500 B.C.), Poverty Point (1,500 – 500 B.C.), Tchula (500 B.C. – A.D. 1), Marksville (A.D. 1 - 400), Baytown (A.D. 400 - 700), Coles Creek (A.D. 700 - 1200), and Mississippian (A.D. 1200 - 1700). The historic period begins at approximately A.D. 1700, and historic perspectives include the Attakapa Indians, first European settlement in Attakapa country, the Acadian migration, the Louisiana Purchase with the western boundary of the United States in dispute until 1819, the Civil War, postbellum period, and the early 20th century.

The NED alternative is located within the Marginal Plain and the Pleistocene Prairie Terrace, while the NER alternatives are limited to the Marginal Plain. Archaeological sites in the southernmost portion of the area postdate the formation of the Marginal Plain (or Chenier Plain) at the end of the Pleistocene Epoch.

Numerous archaeological sites have been previously recorded within a one-mile buffer of the NED alternative. Standing structures that have been identified as potential candidates for nonstructural measures likely have a minimum age of 50 years and have not been assessed for eligibility. Sixteen historic properties have been identified in the study area, including 12 that are listed in the National Register of Historic Places (NRHP).

Twenty-seven archaeological sites have been identified within a one-mile buffer of the NER alternatives. The

recorded sites include one prehistoric sites that has been determined potentially eligible for listing in the NRHP and eight archaeological sites, seven of which are prehistoric, that have been determined not eligible for listing in the NRHP. The remaining 18 have not been assessed. No previously recorded sites have been identified within the proposed borrow areas. Forty-eight historic standing structures have been recorded within the one-mile buffer, and additional standing structures that have a minimum age of 50 years have not been assessed for eligibility.

The above information is detailed in the draft *Cultural Resources Assessment and Research Design for the Southwest Coastal Louisiana Project, Calcasieu, Cameron, Iberia, Jefferson Davis, and Vermilion Parishes, Louisiana* on file with the Louisiana Division of Archaeology (Wells and Hill 2015). The USACE has elected to fulfill its obligations under Section 106 of the NHPA through the execution and implementation of a Programmatic Agreement as provided in 36 CFR Part 800.14(b).

1.4.12 Aesthetics and Visual Resources

Based on available aerial photography, the visual conditions of the study area have changed significantly over the past 20 years. The landscape and view sheds have changed due to the growth of urban development and the loss or change of swamps into marsh, or small open water areas. Comparisons between the 1992 and 2010 photography show that the same public thoroughfares that are in place today were in place then; however, the scenery has changed from natural to a more developed state with residential, commercial and industrial development dominating U.S. Highway 90, I-10, and the state and parish roads in the areas surrounding Lafayette and Lake Charles. The areas to the south in Cameron and Vermillion Parish are still relatively rural, giving the viewer near unobstructed views of a native landscape that has remained aesthetically pleasing during this twenty year time frame. Primary view sheds then, as they are today, were best taken from the local road system.

The Louisiana Scenic Rivers Act of 1988 was established to preserve, protect, and enhance the wilderness qualities, scenic beauties, and ecological regimes of rivers and streams in the state. There is one identified Scenic Stream located near the study area. Calcasieu River is located in the northeastern corner of Calcasieu Parish. The portion of Calcasieu River that qualifies as scenic stretches from the northeastern corner of Calcasieu Parish northeast into Allen Parish south some 34 miles. The Calcasieu River flows through a relatively uniform type of mixed pine-hardwood forest of uneven ages on low, rolling, well drained hills. Much of the timberland is grazed by cattle which tend to lower its value for wildlife. The best habitat can be found immediately adjacent to the stream where the area exhibits high habitat diversity.

Access to the study area is in abundance with highways and byways crisscrossing the region along with local streets and neighborhoods in the more developed portions. Scenic Byways in the area include the Creole Nature Trail; which traverses State and Parish Highways 82, 27, 384, 385, and 397. This Scenic Byway is both state and federally designated and also has an "All American Road" status, making it significant in culture, history, recreation, archeology, aesthetics and tourism. Other Scenic Byways include the Zydeco Cajun Priairie Scenic Byway, located just north of Lafayette and the Jean Lafitte Scenic Byway, located just south of Lafayette. Both of these byways carry a state designation only, but are no less significant in their importance to the region in terms of tourism, scenic vistas, recreation and the local economy.

The Calcasieu River flows through a relatively uniform type of mixed pine-hardwood forest of uneven ages on low, rolling, well drained hills. Much of the timberland is grazed by cattle which tend to lower its value for wildlife. The best habitat can be found immediately adjacent to the stream where the area exhibits high habitat diversity. Recreation opportunities are abundant and include canoeing and fishing but access is relatively limited.

Other major water resources include the Gulf of Mexico, Sabine Lake, Calcasieu Lake, Grand Lake, White Lake and Vermillion Bay as large bodies of water. Within the coastal parishes there is an abundance of varying water bodies both salt and fresh water mixed with marsh, swamp and wetland. Numerous canals, streams and creeks crisscross the native habitat south of I-10 and the more developed areas along that corridor.

There are a variety of eco-regions within the area. Cameron Parish is primarily made up of Texas – Louisiana Coastal Marshes. Vermilion Parish is made up of Northern Humid Gulf Coastal Prairies in the northwest, Lafayette Loess Plains in the northeast, and Texas – Louisiana Coastal Marshes in the south. Calcasieu Parish is made up of Northern Humid Gulf Coastal Prairies in the southern parish of the parish, Flatwoods in the northern portion of the parish, and small pockets of Texas – Louisiana Coastal Marshes along the Calcasieu River corridor (according to the State of Louisiana Eco-Region Map, ref. "Louisiana Speaks").

The Northern Humid Gulf Coast Prairies originally contained tallgrass grasslands with gallery forests along streams paired with gently sloping coastal plain. In modern times, almost all of the coastal prairies have been converted to croplands, pasture, aquaculture or urban land uses. Texas – Louisiana Coastal Marshes is an area characterized by extensive freshwater and saltwater coastal marshes, few bays, and lack of barrier islands. There are many rivers, lakes, bayous, tidal channels, and canals. Chenier plains occupy about three percent of the region and are typically treeless. Lafayette Loess plains originally were home to a variety of plant species that included trees and grasses. In modern times native species have been replaced with crops of rice, soybeans, cotton, sugarcane, sweet potatoes, wheat, and aquaculture. Urban expansion into this eco-region has been substantial. Flatwoods generally occurs on mostly flat to gently sloping sediments. This eco-region was once dominated by longleaf pine flatwoods and savannas, pimple mounds, and small hillocks. While reduction of these characteristics has taken place, these features still dominate the area, especially in the case of the longleaf pine.

Access to the area is in abundance with highways and byways crisscrossing the region along with local streets and neighborhoods in the more developed portions. Scenic Byways in the area include the Creole Nature Trail; which traverses State and Parish Highways 82, 27, 384, 385, and 397. This Scenic Byway is both state and federally designated and also has an "All American Road" status, making it significant in culture, history, recreation, archeology, aesthetics and tourism. Other Scenic Byways include the Zydeco Cajun Prairie Scenic Byway, located just north of Lafayette and the Jean Lafitte Scenic Byway, located just south of Lafayette. Both of these byways carry a state designation only, but are no less significant in their importance to the region in terms of tourism, recreation and the local economy.

Other entities with institutional and public significance include the Sabine National Wildlife Refuge, Cameron Prairie National Wildlife Refuge, and Lacassine National Wildlife Refuge, all of which are located in Cameron Parish, and, finally, Sam Houston Jones State Park, which is located in Calcasieu Parish. These state and federally protected areas offer a refuge for the landscape and wildlife of southeast Louisiana and important recreational opportunities.

1.4.13 Recreation Resources – see Recreation Annex

1.4.14 Noise

Noise, or unwanted sound, may be objectionable in terms of the nuisance, health, or well-being effects it may have upon humans and the human environment, as well as upon animals and ecological systems (Kryter 1994). Generally, noise is a localized phenomenon. Regulations for Occupational Noise Exposure (29 CFR §1910.95) under the Occupational Safety and Health Act of 1970, as amended, establishes a means for effective coordination of Federal activities in noise control and to provide information to the public regarding noise emissions. There are many different noise sources throughout the area including commercial and recreational boats, and other recreational vehicles; automobiles and trucks, and all-terrain vehicles; aircraft; machinery and motors; and industry-related noise.

1.5 Future Without Project Conditions (No Action Alternative)

This section presents the future without project conditions for the human and natural environment for not implementing a Federal project or taking No Action. For all resources discussed below there would be no direct effects from taking 'no action'.

1.5.4 Human Environment

1.5.4.1 Population and Housing

Future Without-Project Conditions (No Action Alternative)

Changes in population, households, and housing are expected to follow the growth in employment within the area. Recent trend analysis (Moody's Analytics 2008) indicates an increase of 15,000 residents and

approximately 5,600 residential structures projected for the area which will impact estimates of employment, as described in the next section. Generally, the overall population is projected to increase. However, the Cameron Parish population is projected continue its trend of decreasing since 2000 (Table 1-15).

Table-1-15: Projected parish population (in thousands)

Parish	Population		
	2020	2030	2080
Calcasieu	195.0	200	236.7
Cameron	6.6	6.6	3.9
Vermillion	59.9	63	76.8
Total	261.4	269.6	317.4

A single catastrophic storm surge event or multiple events could result in significant damage to economic assets including primarily residential, commercial, and industrial structures. Additionally, property owners could potentially incur higher insurance premiums offered by the National Flood Insurance Program (NFIP) should flood rate insurance maps (FIRM) be updated to reflect an increase in risk over time due to relative sea level rise.

Indirect impacts include an increased potential for flood damage to economic assets due to relative sea level rise. As a consequence of this increased flood risk, property owners and the NFIP (if insured) over time would together incur increased costs to repair flood-damaged property. Additional costs to implement appropriate mitigation measures to address potential increased flood risk would also be incurred. Such mitigation could include the migration (or displacement) of affected populations from areas exposed to high flood risk to area with relatively lower flood risk. Migration out of the area could also aisle from the temporary or permanent relocation of businesses and employment opportunities.

1.5.4.2 Employment, Business, and Industrial Activity (including Agriculture)

Future Without-Project Conditions (No Action Alternative)

Indirect impacts would include a higher potential for temporary interruption or permanent displacement of employment, business, and industrial activity as businesses temporarily or permanently relocate to areas with less storm damage risk. Growth in employment, business and industrial activity is expected to follow national economic trends to the extent that economic growth is dependent upon macroeconomic variables such as inflation, interest rates, and the business cycle. However, employment in this region is also partially dependent on the petroleum exploration, production, and refining industries, which do not necessarily correlate with national economic trends. Employment trends (Moody's Analytics 2008) suggests growth from 2012 to 2038 with an additional 6,880 jobs projected by the year 2038 (Table 1-16). Cameron Parish, employment is expected to stabilize at 2012 levels (Moody's Analytics 2008).

Table 1-16: Projected non-farm employment (in thousands)

PARISH	2012	2020	2030	2038
Calcasieu	91.89	96.5	95.5	95.4
Cameron	2.69	2.8	2.7	2.7
Vermilion	16.54	17.7	18.4	19.9
Total	111.12	116.9	116.5	118.0

Source: Moody's Analytics

One or more series of catastrophic storm surge events in the future could result in significant disruption to business and industrial activity that could adversely affect employment and population. Such catastrophic events causing significant damage to non-residential, commercial, and industrial structures would likely increase over time as a result of multiple factors such as relative sea level rise and global warming (source: http://www.climatehotmap.org/global-warming-effects/economy.html accessed October 30, 2013).

Additionally, business owners in these communities could potentially incur higher flood insurance premiums should the FIRMs be updated to reflect an increase in flood risk over time.

1.5.4.3 Public Facilities and Services

Future Without-Project Conditions (No Action Alternative)

Indirect impacts would include a greater potential for permanent displacement of public facilities and services due to storm surge events. Public facilities and services are expected to grow with the needs of the population and would follow population growth trends. In addition to the existing 603 public and quasi-public buildings, an additional 193 such facilities are projected by 2080. These projected facilities are expected to be placed at elevations above the 100-year floodplain. Over time, all facilities would be more susceptible to damages resulting from future hurricane and storm surge events as relative sea level rise occurs. The increased risk of damage to public facilities and the resulting temporary or potentially permanent relocation of these facilities would have a negative impact on services which would no longer be available either temporarily or permanently.

1.5.4.4 Transportation

Future Without-Project Conditions (No Action Alternative)

Transportation infrastructure would be more susceptible to damages resulting from storm surge events due to expected relative sea level rise. There would also be reduced access to infrastructure due to storm surge.

1.5.4.5 Community and Regional Growth

Future Without-Project Conditions (No Action Alternative)

Income growth and associated community and regional growth are expected to follow trends in national income, local employment, household formation, and the demand for public facilities and services. There would also be a higher potential for unstable or disrupted community and regional growth due to increasing risk of damage from storm surge events.

1.5.4.6 Tax Revenues and Property Values

Future Without-Project Conditions (No Action Alternative)

Indirect impacts would include lower tax revenues as property values decline due to higher risk of damage from storm surge events over time. The real estate market cycle is the primary factor in establishing existing and future property values at any point in time. However, over the period of analysis (50 years) changes in property values would be primarily reflective of the growth in income. As flood risk grows over time due to higher surge events as a feature of relative sea level rise, the effects of higher flood risk would continue to suppress real estate market values for residential and non-residential properties. As in other coastal regions, higher flood risk would manifest itself in higher premiums for flood insurance under the NFIP: higher premiums are expected to increase the cost of property ownership and result in correspondingly lower market values. In extreme cases, such premiums are expected to rise to such high levels that the cost of flood insurance would become prohibitively expensive to some property owners. As a result, some properties would not be marketable and their values could be reduced to an extremely low level. To the extent that government assessments of these properties accurately reflect the diminished market values, the tax base could be reduced and property tax revenues could decline.

Some property owners would choose to reduce higher expected future flood risk through mitigation activities. These activities would primarily include, but are not limited to, structure elevation, flood-proofing of commercial structures, and relocation to less risky portions of the study area. Each of these mitigation efforts require substantial financial resources to implement, whether these costs are borne by the property owner or are supplemented, in whole or in part, by public assistance.

1.5.4.7 Community Cohesion

Future Without-Project Conditions (No Action Alternative)

The area would become more susceptible to damage caused by storm surge events that is projected to increase over the period of analysis. The increased risk of damage to residential and non-residential structures and the resulting temporary and/or permanent relocation of populations would negatively affect the community cohesion in many communities. Additional indirect effects would include a greater potential for

reducing community cohesion if the civic infrastructure continues to be damaged as a result of storm surge events. Community cohesion may also be reduced if residents and businesses relocate to lower-risk areas.

1.5.4.8 Other Social Effects (OSE)

Future Without-Project Conditions (No Action Alternative)

The area's social vulnerability is expected to increase over time if subsidence and sea level rise continue to increase, and the population in the study area increases as it is projected to do. The absolute number of socially vulnerable people (e.g., low-income, minority, less-educated, and over the age of 65) at risk for flood events will increase. This, in turn, may lead to an increased burden placed on local, state, and federal agencies to ensure that the most socially vulnerable populations have access to resources before, during, and after flood events.

1.5.4.9 Environmental Justice

Future Without-Project Conditions (No Action Alternative)

Indirect impacts would include a higher potential for temporary displacement of minority and/or low-income populations because residents within the project area would remain vulnerable to flooding and may be forced to relocate to areas with risk reduction features in place. Storm surge increase due to subsidence and sea level rise will exacerbate their vulnerability to flooding. Low-income populations may also find it more difficult to bear the cost of evacuation. This alternative would not contribute to any additional EJ issues when combined with other Federal, state, local, and private risk reduction efforts.

1.5.5 Water Environment

1.5.5.1 Relative Sea Level Rise

Future Without-Project Conditions (No Action Alternative)

Sea level rise (SLR) conditions were simulated by incorporating the predicted subsidence levels into the initial water elevation parameter to capture the combined effects of subsidence and local SLR into a single RSLR value. For the 2025 and 2075 hydrologic simulations, RSLR values specific to each gage were added to the 2013 initial water surface elevations (WSE) to calculate the initial WSE appropriate for each year and SLR rate. SLR and RSLR data is listed in Table 1-17 and shown in Figure 1-13. Four gages were used for the entire RSLR analysis, however only the gage closest to the main area with potential benefits is shown.

Table 1-17: RSLR rise for the gage on the GIWW west of Calcasieu Lock.

Year and SLR Scenario	Calcasieu West RSLR increment (in feet)	Calcasieu West gage elevations (NAVD88 feet)
2025 Low SLR	0.16	0.78
2025 Intermediate SLR	0.22	0.84
2025 High SLR	0.40	1.02
2075 Low SLR	0.85	1.47
2075 Intermediate SLR	1.42	2.04
2075 High SLR	3.24	3.86

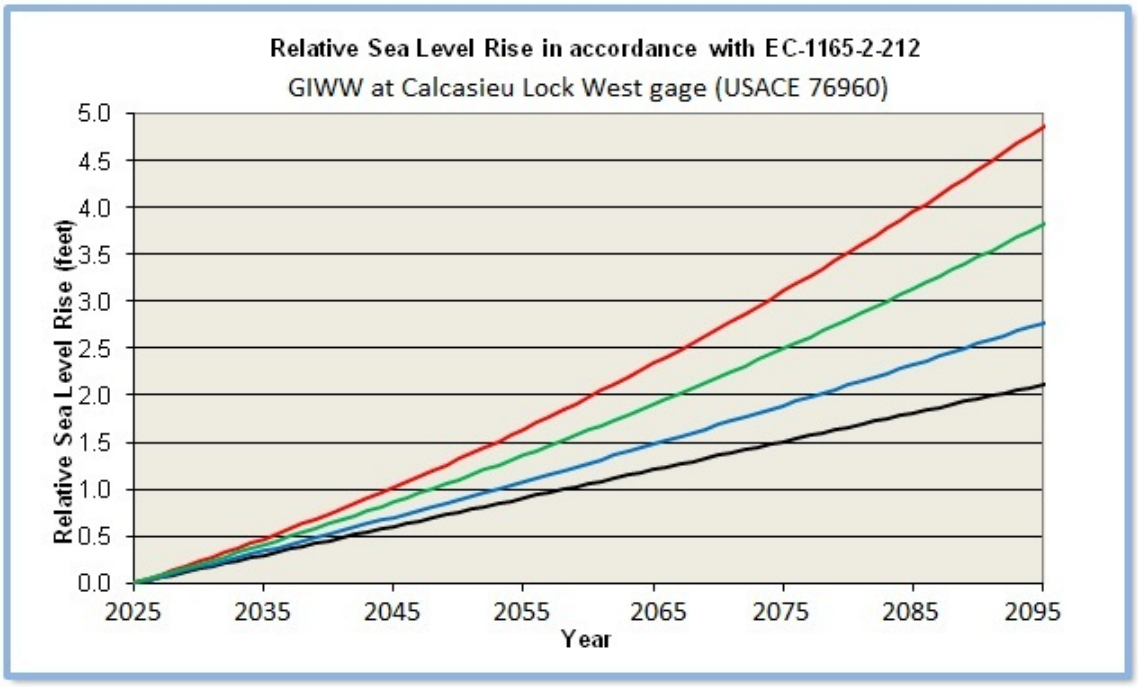

Figure 1-13: Relative sea level rise in the project area.
Black = extrapolation of historic rate Blue = low RSLR. Green = intermediate RSLR. Red = high RSLR.

1.5.5.2 Hydrology and Hydraulics

Future Without-Project Conditions (No Action Alternative)

In the immediate area of Lake Charles, 100-year frequency event water levels are estimated to rise between 0.47 ft and 1.19 ft between 2013 and 2075. In the surrounding marsh areas for all parishes, water levels are estimated to rise between 1.30 ft and 7.40 ft. For the areas along I-10 such as Welsh, Jennings, and Crowley that are far away from any water source connected to the Gulf of Mexico, there is no estimated rise in water surface elevations. This data is shown in tables in the Engineering appendix - Southwest Coastal Louisiana Explanation of FWOP Results. This analysis is based upon the intermediate rate of relative sea level rise. Adding marsh accretion raises water levels slightly in the marsh areas, while not impacting any NED areas.

1.5.5.3 Flow and Water Levels

Future Without-Project Conditions (No Action Alternative)

Indirect impacts would be the continuation of the existing water flow and water level trends. As existing marsh fragments and is eventually converted to open water, the rainfall runoff from the north and the increasing sea level rise would result in the area converting to greater expanses of fragmented marsh and open water. As sea levels rise, existing locks and control structures used for salinity control would be closed on a more frequent basis over time until they would be closed all the time to prevent saltwater intrusion. Natural drainage pattern flow paths would remain unchanged; however, as sea levels rise, drainage times would increase.

1.5.5.4 Water Quality and Salinity

Future Without-Project Conditions (No Action Alternative)

Existing water quality trends would be expected to continue. Without the proposed project there would be an increased risk of flooding of the urban areas, and drainage of floodwaters containing elevated nutrients, metals, and organics into waterbodies connected to the Calcasieu, Mermentau, and Tech-Vermillion river basins is a possibility. Without the proposed project, study area would still be affected by existing and proposed restoration efforts, chenier geomorphologic processes, development (in particular, oil and gas development in the Calcasieu River basin and agriculture in the Mermentau River basin), and climate patterns (Mousavi et al. 2011).

1.5.6 Natural Environment

1.5.6.1 Sedimentation and Erosion

Future Without-Project Conditions (No Action Alternative)
Indirect effects would include persistence of current sedimentation and erosion patterns. Relative sea level rise would expose additional shoreline areas to erosive forces into the foreseeable future. Existing hydrologic alterations would continue to impact water levels and salinities and continue influencing land loss at similar or increased rates.

North White Lake in the Mermentau Basin is expected to lose approximately 3,500 acres of freshwater marsh by 2050 (Coast 2050) resulting from shoreline erosion. South White Lake is expected to lose approximately 4,200 acres of freshwater marsh by 2050. The Vermilion Bay Marshes are expected to lose 13,560 acres of marsh by 2050 (Coast 2050). Rainey Marsh is expected to lose approximately 7,900 acres by 2050 (Coast 2050).

1.5.6.2 Soils, Water Bottoms and Prime and Unique Farmlands

Future Without-Project Conditions (No Action Alternative)
Indirect effects would be the continuation of existing conditions with coastal shoreline recession, subsidence and land loss continuing at similar or increasing rates of change. As RSLR increases and areas become inundated by salt water, prime farmlands could be lost.

Some unknown extent of existing oak-pine forest habitats would likely be converted to pasture, agriculture, rural, suburban and urban human habitats. As human populations and development increase, prime farmlands could be converted to suburban, urban, and industrial uses and areas available for agricultural use would decrease.
Gulf shoreline recession rates, varying between 8 feet to 52.9 ft per year, would result in Gulf shoreline rollover onto back barrier marsh and cheniers would continue to be lost throughout the southwest coastal area due to subsidence and change in land use patterns from forested areas to agriculture and grazing pasture. Soils identified as prime farmlands on chenier ridge tops would be susceptible to flooding events and subsidence and could be lost as RSLR increases.

1.5.6.3 Gulf Coastal Shorelines

Future Without-Project Conditions (No Action Alternative)
Indirect effects would be the continuation of existing conditions with coastal shoreline recession, subsidence and land loss continuing at similar or increasing rates of change. The loss of these coastal shorelines would also adversely impact the extraordinary scenic, scientific, recreational, natural, historical, archeological, cultural, and economic importance of the coastal shorelines. The continued loss of coastal shorelines would result in the reduction and eventual loss of the natural protective storm buffering. Without the protective buffer provided by the coastal shorelines, interior estuarine wetlands would be at an increased risk to severe damage from tropical storm events. Continued shoreline recession, subsidence and land loss resulting in the movement of unstable sediments would undermine man-made structures, especially the extensive oil and gas pipelines and related structures in this "working coastline."

1.5.6.4 Vegetation Resources

Future Without-Project Conditions (No Action Alternative)
Indirect effects would be the continuation of existing conditions and factors driving trajectories of ecological change to area vegetation zones. Without an extensive ecosystem restoration plan, marsh habitat would continue to be restored through other restoration projects and programs such as those authorized for construction through CWPPRA, CIAP, and LCA, but not on a large and broad enough scale to completely restore natural processes and features vital to the long-term sustainability of the watershed. Without action, the coastal vegetated resources would continue to decline, including bankline erosion and sloughing of the shoreline, and continued fragmentation and conversion of existing brackish and saline marsh to shallow open water habitats. Both human-induced impacts and natural processes would contribute to the continued loss of vegetated habitats, including continued shoreline erosion and subsidence, increased saltwater intrusion, increased water velocities, and increased herbivory.

Gulf Coast Prairie and Forested Terraced Uplands:

- Some unknown extent of existing oak-pine forest habitats would likely be converted to pasture,

agriculture, rural, suburban and urban habitats, generally in this order of conversion, as human populations and development increase.

- Some unknown extent of existing riverine BLH and associated swamp habitats would be converted to more efficient water conveyance channels as human populations and development increase.
- Some unknown extent of existing pasture and rangelands would be converted to rural, suburban and urban human habitats, generally in the order presented, as human populations and development increase.

Gulf Coast Marshes

- Habitat switching would occur due to increasing sea level rise, subsidence, shoreline erosion and other land loss drivers.
- Gulf shoreline recession rates, varying between 8 ft to 52.9 ft per year, would result in Gulf shoreline rollover onto back barrier marsh thereby converting these existing habitats.
- Chenier ridge habitat is being lost throughout the southwest coastal area due to subsidence and change in land use patterns from forested areas to agriculture and grazing pasture. However, no loss of chenier habitat is anticipated within the proposed restoration areas because these areas are at least +4 foot NAVD88.
- Inland ponds and lakes shoreline loss rates, varying between 3.6 feet and 9.3 feet, would result in conversion of existing salt, brackish, and intermediate/fresh marsh to shallow open water habitats.
- Habitat switching of interior marsh could from saline intolerant dominant species to species that can tolerate higher salinities.
- SAVs could become lost due to erosive forces and increased sedimentation due to land loss.

Table 1-18 displays the NER restoration feature habitat type, acres, and quality by hydrologic basin for comparison between the future without and future with project conditions (also reference chapter 2 for plan formulation details and description of the NER TSP).

Table 1-18: NER Features by Basin

Basin	Category	Feature	Habitat Type	FWOP Acres	FWP Net Acres	NET AAHUs[1]
Mermentau/Teche-Vermilion	Marsh Restoration	47a1	Brackish	0	895	272
		47a2	Brackish	0	1,218	381
		47c1	Brackish	0	1,135	353
		127c3	Brackish	0	735	241
		306a1	Brackish	1,945	743	645
	Shore Protection	6b1	Saline	0	2,140	625
		6b2	Saline	0	1,583	466
		6b3	Saline	0	1,098	312
		16b	Brackish	1,456	662	156
	Chenier Restoration	CR	BLH	282	100 planted	96[3]
Calcasieu/Sabine	Hydraulic/ Salinity Control	74a	Unknown		56[2]	267[2]
	Marsh Restoration	3a1	Brackish	0	454	191
		3c1	Brackish	0	1,451	654
		124c	Saline	248	1,915	740
		124d	Saline	307	168	4
	Shore Protection	5a	Barrier Headland	0	26	56[3]
	Chenier Restoration	CR	BLH	1,132	484 planted	442[3]
	Oyster Reef	ORP	Oyster Reefs		~1,480[4]	N/A[4]

	Protection					

Data collected for the State of Louisiana Master Plan model runs (not the results of) was used for WVA models.[1]A non certified version of the WVA model was used for all marsh restoration features reported in the draft report. A re- analysis utilizing certified WVA marsh models has been accomplished and is reported above.

[2] Separate WVAs were not run for the Hydraulic/Salinity Control features. The numbers presented here are based on WVAs run for multiple features and are mathematical subtractions from plans with and without the feature.

[3] The BLH and Barrier Headland WVA models used are certified models with no restrictions on use.

[4] This feature has been removed from the TSP and recommended that the State take action to preserve this oyster reef.

1.5.6.5 Rare, Unique, and Imperiled Vegetative Communities

Future Without-Project Conditions (No Action Alternative)

Existing conditions and trends of land loss are expected to continue resulting over time in the loss of these valuable vegetative communities. For example, without action, saltwater intrusion and drainage problems would continue, resulting in the conversion of freshwater marsh to intermediate and brackish marsh and eventual open water.

1.5.6.6 Wildlife Resources

Future Without-Project Conditions (No Action Alternative)

Existing conditions and changes caused by ecosystem drivers would persist. RSLR, human encroachment and development and other factors would result in loss of existing wildlife estuarine, chenier, riverine and oak-pine forest habitats. Increases in RSLR would increase saltwater intrusion and exacerbate ongoing conversion of estuarine wetlands to shallow open water. As habitat loss continues, migratory neotropic avian species would have less habitat for resting forcing them to fly further to suitable habitat. Flying longer distances to find suitable stopover habitat could result in an increase in mortality resulting in a corresponding reduction in overall species diversity and abundance. Most mammalian, amphibian, and reptilian species would migrate to more suitable habitats. Wildlife would benefit from restoration activities implemented by other programs such as CIAP, CWPPRA, and beneficial use of dredged material. However, these activities are not enough to keep up with the current trends in habitat loss and RSLR.

1.5.6.7 Aquatic and Fisheries Resources

Future Without-Project Conditions (No Action Alternative)

Existing conditions and associated changes due to ecosystem drivers would likely persist into the future. Increases in RSLR would increase saltwater intrusion and exacerbate ongoing conversion of estuarine wetlands to shallow open water and loss of existing estuarine fish habitats. Increases in RSLR could exacerbate ongoing conversion of existing aquatic organism distributions from an estuarine-dependent to more marine-dependent distribution. As habitat loss continues, there would be a corresponding reduction in overall species diversity and abundance as well as loss of estuarine nursery, foraging, refugia, and other estuarine aquatic habitats. Aquatic and fisheries would benefit from restoration activities implemented by other programs such as CIAP, CWPPRA, and beneficial use of dredged material; however, these activities are not enough to keep up with the current trends in habitat loss and RSLR.

1.5.6.8 Essential Fish Habitat (EFH)

Future Without-Project Conditions (No Action Alternative)

Existing trends and continued shoreline erosion, subsidence and land loss would continue to convert existing estuarine EFH to marine and open water EFH types resulting in the loss of existing estuarine EFH but an increase in the other types.

1.5.6.9 Threatened and Endangered Species

Future Without-Project Conditions (No Action Alternative)

Land loss would directly reduce the availability of habitat for T&E species. Piping plover would lose access to some forage and roosting habitat as it shifts to shallow open water. As interior marshes are lost, shoreline retreat rates increase. The coastal habitat utilized by sea turtles would continue to be impacted from this

accelerated shoreline retreat rate. The continued erosion of the Gulf coast shoreline would result in additional salt water intrusion into the interior wetlands area resulting in additional marsh loss. Conversely, the recently delisted brown pelicans would gain access to more shallow water foraging areas, resulting from the shoreline retreat. Indirect effects would be the continued reduction of piping plover critical wintering habitat due to coastal erosion. The primary consequence of not implementing the NER plan would be the continued degradation and loss of emergent wetland habitats used by many different fish and wildlife species for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements. The loss and deterioration of transitional wetland habitats over time could continue to indirectly affect, to an undetermined degree, all listed species that may potentially utilize the area including: Gulf sturgeon, piping plovers, red knots, green sea turtles, Kemp's Ridley sea turtles, loggerhead, sea turtles, hawksbill sea turtles, leatherback sea turtles, and the West Indian manatee. The recovery of some sensitive/delisted species such as brown pelican, bald eagle, and colonial nesting birds could be indirectly impacted if habitat loss goes unabated.

1.5.6.10 Historic and Cultural Resources

Future Without-Project Conditions (No Action Alternative)

Impacts to historic and cultural resources in southwest Louisiana have resulted from both natural processes, such as redeposition, and human activities. Coastal environments are dynamic, and impacts to cultural and historic resources in the area would continue as a result of both natural processes and human modifications of the coastal environment of southwest Louisiana.

1.5.6.11 Aesthetics and Visual Resources

Future Without-Project Conditions (No Action Alternative)

There would be no direct, indirect or cumulative effects.

1.5.6.12 Recreation Resources – See Recreation Annex

Future Without-Project Conditions (No Action Alternative)

There would be no direct impacts to recreational resources under the future without project condition. Indirectly, the continued loss of wetlands/marshes and habitat diversity affects recreational opportunities. Storm surge and saltwater could influence freshwater forests and habitats and could reduce recreational resources (e.g., fishing, hunting, bird watching, and other). In general, further degradation of area marshes would continue and its associated negative effects on recreation activities would increase. Additionally, there may be indirect impacts felt by marinas and other shops, which may be two-fold. One is losing the actual facility or access to the facility by way of storm surge, the other is change in opportunities. Habitat change and resulting changing recreation opportunities (i.e. fresh to marine) may, for example, severely impact a marina specializing in services to particular types of recreation (i.e. loss of freshwater fishing and hunting opportunities).

1.5.6.13 Noise

Future Without-Project Conditions (No Action Alternative)

There would be no direct, indirect or cumulative effects.

1.6 Cumulative Impacts for Future Without Project Conditions

Cumulative impacts would be the incremental direct and indirect effects of not implementing proposed NED and NER efforts. These incremental effects would be in addition to the direct and indirect effects attributable to the lost opportunity of not implementing other HSDRR or ecosystem restoration efforts which have been considered, but for whatever reasons are not or would not be implemented.

There is little published data with which to provide a quantitative comparison regarding HSDRR or ecosystem restoration projects which have been considered but have not been authorized for implementation or have not been constructed throughout Louisiana. Some information regarding such efforts:

- The 1990 Coastal Wetlands Coastal Wetlands Planning, Protection and Restoration Act, (CWPPRA; Public Law 101-646, Title III CWPPRA).
- The 1998 *Coast 2050: Toward a Sustainable Coastal Louisiana* plan to address Louisiana's costal land loss and provide for a sustainable costal ecosystem. This collective effort among Federal, State, and local governments was affirmed by the adoption of the plan by the Louisiana Coastal Wetlands

Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority as their official restoration plan; transmission of this plan to the U.S. Department of Commerce by the State of Louisiana to incorporate it into the Louisiana Coastal Resources Program Guidelines; and resolutions of support from 20 coastal parish councils and police juries.

- The Louisiana Coastal Area (LCA), Louisiana Ecosystem Restoration Study (hereinafter "LCA Plan," USACE 2004).
- Louisiana's Comprehensive Master Plan for a Sustainable Coast (hereinafter "2012 State Master Plan; CPRA 2012).

Since its inception, the CWPPRA program has authorized for construction 151 coastal restoration or protection projects, benefiting over 110,000 acres in Louisiana (source: http://lacoast.gov/new/About/#projects accessed October 22, 2013). However, hundreds of ecosystem restoration projects have been considered as candidate or demonstration projects. Of these, approximately 253 projects were not selected for detailed consideration (personal communication Ms. Susan Hennington, USACE Representative CWPPRA, on October 24, 2013).

LCA Plan: In November 2007, Title VII of the Water Resources Development Act of 2007 (WRDA '07) became law, authorizing a $1.996 billion Louisiana Coastal Area (LCA) Program in accordance with the 2004 feasibility report and subsequently the 2005 LCA Chief's Report, which were developed in partnership with the State of Louisiana. The LCA program consists of three major types of projects: 1) barrier island restoration; 2) marsh creation or restoration; and 3) Mississippi River diversions. All three types of projects independently generate restoration benefits, but together they provide greater sustainability and resilience for the coastal ecosystem.

In May 2014, the Water Resources Reform and Development Act of 2014 (WRRDA 2014) became law and Sec 7002 increased the WRDA 07 authorized amounts for 6 projects known as the LCA 6; Multipurpose Operation of Houma Navigation Lock and Convey Atchafalaya River Water; Terrebonne Basin Barrier Shoreline Restoration; Small Diversion at Convent Blind; Amite River Diversion Canal Modification; Medium Diversion at White Ditch from the WRDA 2007 amount of $543,600 to $1,627,000,000 for these 6 projects. In addition, WRRDA 2014 increased the WRDA 07 authorized amount for the Barataria Basin Barrier Shoreline (BBBS) Restoration project from the WRDA07 amount of $242,600,000 to $495,000,000. The LCA Program is intended to address the most critical near-term needs of coastal Louisiana through the construction of projects to arrest further wetland loss, which will allow for development of a more comprehensive solution to restore the ecosystem in the long-term. Fifteen projects and studies are considered near-term critical restoration features in the near-term plan (See Figure 2) and, are marked with an asterisk below.

On May 22, 2012, the Louisiana legislature unanimously approved the 2012 State Master Plan for a Sustainable Coast (State Master Plan), a $50 billion, 50-year plan to substantially increase flood protection for communities and create a sustainable coast. By executive order of the Governor of the State of Louisiana, all activities, studies, decisions, and commitments from this point forward by the State government will conform to and be consistent with the State Master Plan. As such, the State Master Plan is intended to guide State participation in future studies and investments in risk reduction and restoration projects in Louisiana, including those in collaboration with the Corps. The approval of the State Master Plan places the LCA program at a pivotal point. The Coastal Protection and Restoration Authority Board of Louisiana, on behalf of the State, has assessed all on-going and planned coastal ecosystem restoration studies and projects, including LCA projects, to ensure alignment with the State Master Plan.

The State is working in partnership with the USACE on the Mississippi River Hydrodynamic and Delta Management study which will provide important scientific and engineering technical information necessary for developing diversions throughout the Mississippi River Delta.

The 2012 State Master Plan (CPRA 2012) states that more than 23 large-scale studies and planning efforts have been conducted for coastal Louisiana since the 1920's. The State developed and screened over 1,500 project ideas to develop a more manageable number of candidate projects. From this, the State evaluated 248

restoration projects, 33 structural and 116 conceptual non-structural flood risk reduction projects. The State acknowledges that each project has its own timeline and budget. The 2012 State Master Plan indicates how the State of Louisiana would spend dollars they now have in hand as well as how they would use new dollars that are allocated for Louisiana's coast. It is reasonably foreseeable that some of the identified projects would likely not be constructed.

In response to the 2010 Gulf of Mexico Deepwater Horizon oil spill and to help ensure the long-term restoration and recovery of the Gulf Coast region, the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act of 2012, or the RESTORE Act (herein referred to as Act), was passed by Congress on June 29, 2012, and signed into law by President Obama on July 6, 2012 ((http://www.restorethegulf.gov/sites/default/files/The%20Path%20Forward%20to%20Restoring%20the%20Gulf%20Coast%20-%20Gulf%20Restoration%20Council%20FINAL.pdf accessed November 22, 2013). The Act provides for planning and resources for a regional approach to the long term health of the natural ecosystems and economy of the Gulf Coast region. The Act sets forth the following framework for allocation of the Trust Fund (http://www.restorethegulf.gov/release/2012/11/30/gulf-coast-ecosystem-restoration-council-help-rebuild-gulf-coasts%E2%80%99-ecosystems-and accessed November 22, 2013):

- 35 percent equally divided among the five States for ecological restoration, economic development, and tourism promotion;
- 30 percent plus interest managed by the Council for ecosystem restoration under the Comprehensive Plan;
- 30 percent divided among the States according to a formula to implement State expenditure plans, which require approval of the Council;
- 2.5 percent plus interest for the Gulf Coast Ecosystem Restoration Science, Observation, Monitoring and Technology Program within the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA); and
- 2.5 percent plus interest allocated to the States for Centers of Excellence Research grants, which will each focus on science, technology, and monitoring related to Gulf restoration.

The Act requires the Initial Comprehensive Plan (Plan) to include "a list of projects and programs authorized prior to the date of enactment of [the Act] but not yet commenced, the completion of which would further the purposes and goals of [the Act]." The Department of Agriculture identifies 8 projects; U.S. Forest Service identifies 3 projects; Department of Commerce identifies 6; Department of Interior identifies 3 projects; Louisiana identifies 6 projects; USACE identifies 42 projects; EPA identifies 6 projects specific to Louisiana and 1 project Gulf-wide (http://www.restorethegulf.gov/sites/default/files/Authorized%20But%20Not%20Yet%20Commenced%20List_8-6-13_FINAL.pdf?utm_medium=email&utm_source=govdelivery accessed November 22, 2013):

The cumulative effects of not implementing the proposed action would include the incremental effects of not providing HSDRR and/or ecosystem restoration on the following:

Human Environment

- an estimated population of 225,000 and 15,000 residential structures in the study area in the year 2075;
- employment of 106,000 workers in the three-parish area in the year 2010; 1,580 non-residential structures in the study area by 2075; 808,414 acres of agricultural land within the three-parish area in 2009 projected 603 public and quasi-public buildings; and an additional 193 such facilities projected by 2080;
- transportation infrastructure would be more susceptible to damages resulting from storm surge events due to expected RSLR;
- reduced access to infrastructure due to storm surges;
- community and regional growth;
- tax revenues and property values;

- higher flood insurance premiums would be expected to increase the cost of property ownership and result in correspondingly lower market values;
- continued or increased risk of damage to residential and non-residential structures resulting in temporary and/or permanent relocation of populations would negatively affect the community cohesion in many communities;
- continued temporary displacement of minority and/or low-income populations because residents within the area would remain vulnerable to flooding and may be forced to relocate to areas with risk reduction features in place;
- continued higher flood risks would manifest itself in higher premiums for flood insurance under the NFIP;
- continued shoreline recession, subsidence, and land loss resulting in the movement of unstable sediments would undermine man-made structures, especially the extensive oil and gas pipelines and related structures in this "working coastline;"

Water Environment

- existing hydrologic alterations would continue to impact water levels and salinities and continue influencing land loss at similar or increased rates;
- as sea levels rise, natural drainage pattern flow paths would remain unchanged but drainage times would increase;
- continued salt water intrusion and inundation during hurricane and storm surge events;
- continued erosion by wave and current action resulting in continued shoreline erosion of most channels, lakes, and the Gulf;

Natural Environment

- continued loss of soil resources. The LCA Study (USACE, 2004) estimated coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year over the next 50 years. It is estimated that an additional net loss of 328,000 acres may occur by 2050, which is almost 10 percent of Louisiana's remaining coastal wetlands. However, these wetland soil losses would be offset to some extent by restoration projects implemented through other programs.
- continued increases in RSLR which could increase saltwater intrusion and exacerbate ongoing conversion of existing estuarine wetlands to shallow open water; impacts to cultural and historic resources in the area would continue as a result of both natural processes and cultural modifications of the coastal environment of southwest Louisiana;
- recreational infrastructure and consumptive recreational opportunities would remain vulnerable to hurricanes and storm surges.
- continued conversion of existing vegetated wetlands used as foraging, nesting, and over-wintering habitat to open water habitats;
- reduction in overall species diversity and abundance as well as loss of estuarine nursery, foraging, refugia and other estuarine aquatic habitats;
- continued bankline erosion and sloughing of the shoreline;
- continued encroachment of salinity in areas with brackish and freshwaters;
- continued habitat switching due to increasing RSLR, subsidence, shoreline erosion and other land loss drivers;
- loss of habitat would further stress species that are dependent on these habitats for all or a part of their life cycle.

2.0 Environmental Consequences (*NEPA Required)

This chapter describes the environmental consequences associated with the alternatives for the nonstructural Hurricane and Storm Damage Risk Reduction (HSDRR**)** NED plans and the ecosystem restoration NER plans. The impacts of the NED plans described here are programmatic in nature. Subsequent NEPA documents will analyze in detail site specific NED project(s) impacts prior to implementation. The NER plan features are described and recommended as feasibility-level constructible and NEPA compliant.

2.1 The Human Environment (Socioeconomics)

2.1.1 Population and Housing

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)

Direct impacts include the potential for damage to structures, landscaping and driveways while the structure is being elevated. There would also be potential inconvenience to residents having to move and store their personal possessions and relocate to a temporary residence while their residences are being elevated as well as impede access to the residence during the time the residence is being elevated. Temporary relocation of individuals and families could entail different travel routes through unfamiliar areas, longer commute times to work, school, and other destinations for typical life activities (e.g., shopping, doctor and dentist visits, etc.). The change in commute times could be a positive or negative impact, since the relocation could temporarily move individuals and families either closer or farther away from their destinations. The scope of the acquisition component is unknown, but would result in a displacement of persons, voluntary or not. Displacement would not likely result in a net change of population to the study area, but could result in changes to the populations of individual communities and neighborhoods within and potentially outside the study area. Furthermore, displaced residents could experience different and longer routes travel routes through unfamiliar areas, longer commute times to work, school, and other destinations for typical life activities (e.g., shopping, doctor and dentist visits, etc.).

Indirect Impacts would include reduced flood risk from the surges associated with tropical events for population and housing in the 25-year floodplain of the study area. The reduction in flood risk would lead to greater stability and sustainability of population and housing resources. However, if a residence is elevated, access to the elevated residences could be more difficult, especially for the elderly and physically handicapped, even if retrofitted with elevator and other devises. Additional indirect impacts would be the different visual appearance of neighborhoods and communities with a few elevated structures located within a community of nearby structures that are not elevated. There could also be a potential drainage issues, especially related to construction of berms. There is also a potential that existing landscaping around residential structures could be damaged and require restoration.

Alternative – Nonstructural 100-year Floodplain

The impacts from this alternative are similar but for the most part greater than the impacts from the Nonstructural 0-25 Year Floodplain Plan (TSP) alternative because of the larger numbers of structures that would be included in the program. This is true for all resources hence a discussion of impacts will not be added to each of the following resource unless there is a significant reason for it to be addressed separately in that resource. The scale of the differences would vary by resource.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

Restoration features of this alternative would have no direct impacts on population and housing. Indirect impacts would include decreasing the rate of shoreline erosion, thereby, preserving the temporary population of the Holly Beach camp community located along the shoreline of the Gulf of Mexico.

Alternative – Mermentau Small Integrated Restoration Plan

Impacts are the same as the Mermentau Basin (MB) component of the TSP.

2.1.2 Employment, Business, and Industrial Activity (Including Agriculture)

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)

There would be direct impacts associated with the flood proofing of businesses and the construction of berms in the nonstructural plan. If commercial structures are flood proofed, businesses could potentially either shut down or relocate temporarily while the measure is being applied, which could lead to a loss of revenue, change in business clients to other more available businesses, as well as a loss of wages to employees. Also, the construction of berms around warehouses could temporarily and intermittently impede access to the warehouses during construction and cause drainage issues for adjacent areas and structures. There is a potential that existing landscaping around businesses and warehouses could be damaged and require restoration. The scope of acquisitions for commercial structures is currently unknown. There may not be any such structures that meet the criteria for acquisitions. In the event that a commercial structure is acquired, it is possible that the business could choose to cease operations, resulting in the loss of jobs that it provided, thereby adversely affecting employment in the area. Also, if a business relocates outside of the community, it could face the inconvenience of having to establish itself in a new area as well as longer travel distances and increased transportation costs to move the business products to markets. This inconvenience could take the form of a marketing campaign to raise awareness of the new location, which could result in an expense to the business over and above what would normally be spent. Also, some businesses could relocate beyond what some employees would consider an acceptable commuting distance. This impact could reduce employment or redistribute it, depending on whether these workers find other employment. Furthermore, customers could face the inconvenience of longer commute times and distances if a business they patronize either closes or relocates.

Indirect Impacts would include reduced flood risk from the surges associated with tropical events for employment, business, and industrial activity in the 25-year floodplain of the study area. Also, some businesses could potentially lose customers as a result of residents relocating farther away due to their homes being acquired, while other businesses could gain customers as residents relocate closer to them.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

Restoration features would have no direct impacts on employment, business, and industrial activity. Indirect effects would include the prevention of land loss, which could result in localized positive effects of maintaining employment, business, and industrial activity. Cumulative impacts would be beneficial and would result from improved sustainability of southwest Louisiana with similar restoration efforts, making a more stable environment for employment, business, and industrial activity.

Alternative - Mermentau Small Integrated Restoration Plan

Impacts are the same as the MB component of the TSP.

2.1.3 Public Facilities and Services

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)

Direct impacts associated with the TSP include interruption or unavailability of public facilities and services during temporary closure or relocation during flood proofing.

Indirect impacts include reduced flood risk from the surges associated with tropical events for public facilities and services in the area thereby reducing the number of days a structure is unavailable for use and minimizing the inconvenience to the general public. Indirect impacts to public facilities and services not included in the plan would be the same as the no-action alternative.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

Restoration features would have no direct, indirect, or cumulative impacts on public facilities or services.

Alternative - Mermentau Small Integrated Restoration Plan

Impacts are the same as MB component of the TSP.

2.1.4 Transportation

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)

There could be minor indirect short term impact to transportation due to construction related activities from both elevations and buyouts. These impacts will vary depending on the number of structures in each category and the timing of the activities. There would be no long term impact.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

No direct impacts on transportation. Indirect impacts would include mitigating the wave action that Highway 27 is routinely subject to, thereby reducing the frequency and intensity of the damages it sustains.

Alternative - Mermentau Small Integrated Restoration Plan

Impacts are the same as the MB component of the TSP

2.1.5 Community and Regional Growth

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)

No direct impacts. Indirect impacts would include reduced risk of damage for communities from the storm surges associated with tropical events, thus preserving growth opportunities for communities in the region.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

No direct or indirect impacts.

Alternative - Mermentau Small Integrated Restoration Plan

Impacts are the same as MB component of the TSP.

2.1.6 Tax Revenues and Property Values

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)

Parish sales tax revenue would likely increase during implementation of nonstructural measures as a result of an expected influx of workers and construction expenditures from outside of the area. Construction activities associated with the NED plan would provide jobs and could increase the level of spending, labor, and capital expenditures in the area. Indirect impacts may include an increase in tax revenue and property values due to the increased risk reduction from flooding for residential properties and businesses. The tax revenues and property values for properties not included in the program would be the same as the without project values.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

No direct effects to tax revenues and property values. Indirect effects would include the prevention of land loss, which could result in localized positive effects of maintaining tax revenues and property values.

Alternative - Mermentau Small Integrated Restoration Plan

Impacts are the same as the MB component of the TSP.

2.1.7 Other Social Effects (OSE)

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)

A summary of OSEs is presented in the Table 2-1. These include reduction in risks associated with damages from tropical/hurricane storm surge events to housing units, public facilities, and commercial structures located within the floodplain where the TSP is implemented, as well as improvement in the health and safety of those residents living within these and surrounding areas. The social vulnerability of all three parishes would be reduced, and thus, the potential for long-term growth and sustainability would be enhanced. These

areas would be at a reduced risk of incurring costs associated with clean-up, debris removal, and building and infrastructure repair as a result of flood events.

Table 2-1: Summary of other social effects.

OSE Alternative Evaluation				
Social Factors and Metrics	*Nonstructural Measures*	*CB and MB Salinity Control*	*MB*	*No Action*
	DL / FE	DL / FE	DL / FE	DL / FE
Physical Health/Safety	1/2	1/1	0/0	-1/-2
Regional Healthcare	1/2	1/1	0/0	0/-2
Employment Opportunities	1/3	0/0	0/0	-1/-3
Community Cohesion	1/2	0/0	0/0	-1/-1
Vulnerable Groups	1/1	1/1	0/0	-1/-2
Residents of Study Area	1/1	1/1	0/0	-1/-2
Recreational Activities	1/2	1/2	0/1	-1/-2
Impacts are in comparison to the Without Project Condition DL = impacts to daily life when there is no storm/flooding FE = impacts during a storm/flood event Scores can range from -3 (significant negative impact) to +3 (significant positive impact)				

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

This alternative would reduce the risks associated with habitat damage via saltwater intrusion, shoreline retreat, and loss of geomorphologic infrastructure. The area's social vulnerability would be reduced under this alternative via improved leisure and recreation opportunities, access to health and safety facilities, economic vitality, and reduced stress. Thus, the potential for long-term growth and sustainability would be enhanced.

Alternative - Mermentau Small Integrated Restoration Plans

Impacts are the same as the MB component of the TSP.

2.1.8 Community Cohesion

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)

Direct impacts would include the temporary displacement of residents residing in the floodplain benefiting by nonstructural measures. If residential structures were elevated then the residents would be temporarily relocated, disrupting community cohesion during the elevation process. Furthermore, non-residential structures that serve as meeting places for the community could become temporarily unavailable during the floodproofing process.

Indirect impacts for the nonstructural plan would include reduced risk for select communities from the damages associated with tropical/hurricane storm surge events, thus preserving the cohesion of these communities in the region. Depending on the method used on any individual property there may be a cumulative change in the communities.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

No direct or indirect impacts.

Alternative - Mermentau Small Integrated Restoration Plan

Impacts are the same as the MB component of the TSP.

2.1.9 Environmental Justice

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)

Population groups residing or working near the construction site itself may experience direct impacts due to the construction traffic, noise, and dust. Indirect impacts include a decrease in risk of damage from 100-year [1% (and more frequent) ACE)] storm events for minority and/or low-income populations residing in the floodplain where the nonstructural plan is implemented.

It is assumed that all structures within the 100-year (1% ACE) flood zone in the 0-25-year floodplain are flood-proofed, elevated, or acquired; therefore all residents within the this area, irrespective of race, ethnicity, or income, would be expected to be similarly impacted. Further evaluation will determine if the Federal action causes a disproportionate impact to low-income or minority communities.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

Many of the areas are sparsely populated or devoid of permanent structures and/or population. Construction of control structures to reduce saltwater intrusion and tidal influx would temporarily impact leisure and recreation at any nearby camps or designated fishing and hunting spots. Access to some areas due to marsh restoration and nourishment activities may be temporarily interrupted. Impacts due to shoreline protection construction would also be temporary. The long-term benefits of salinity control, marsh restoration, shoreline protection, bank stabilization, chenier reforestation, and oyster reef restoration would improve wetland habitat which would subsequently improve leisure and recreation opportunities. If this alternative encourages regional economic growth, any additional jobs created may benefit minority and/or low-income groups living within the project area. Temporary impacts from construction activities due to increased turbidity, noise, and access interruption are compensated for by the opportunity for long-term positive cumulative impacts as other restoration programs improve the habitat and sustainability of coastal Louisiana.

Alternative - Mermentau Small Integrated Restoration Plan

Impacts are the same as the MB component of the TSP.

2.2 Water Environment (Hydrology and Hydraulics)

2.2.1 Flow and Water Levels

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)

Potential direct and indirect impacts to flow and water depend on the method used.

1. Raising of structures with the use of pilings or buyout could increase storage capacity and lower the surge elevations for those structures not elevated.
2. Raising of structures with the use of earthen mounds, flood proofing or individual ring levees could decrease storage capacity and raise the surge elevations for those structures that not elevated.
3. Raising of structures with the use of cinderblock chain wall would have similar impacts as existing conditions on storage capacity and surge elevations since it would mimic existing conditions of the structure.

The total level of impact would be dependent on the combination of methods and number of structures in each of those methods but at the same time would be minor.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

- *Hydro/Salinity*: General flow patterns would not change.
- *Marsh Restoration*: Existing water levels in fragmented marsh and shallow open water areas would be converted to marsh habitat. Water levels in adjacent lakes would not change. Flows would generally overflow restored and nourished marsh areas.
- *Shoreline Protection*: Segmented breakwaters along the Gulf would dissipate the high energy Gulf waves without changing water levels or flows. Rather, these structures would provide conditions conducive to land building behind them. Interior shoreline protection measures will not alter flows or water levels. Rather, these structures will reduce erosion caused by waves.

- *Cheniers*: No direct or indirect impacts.

Alternative - Mermentau Small Integrated Restoration Plan
Impacts are the same as MB component of TSP.

2.2.2 Water Quality and Salinity

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)
Direct impacts of the nonstructural component would be associated with construction for raising of structures. Indirect impacts of raising structures would be the prevention of flooding during storm surge which would reduce water quality impacts in comparison to FWOP conditions.

Construction impacts to runoff would be minimized through implementation of a Stormwater Pollution Prevention Plan (SWPPP) (USEPA 2012). Any structure demolition and removal would be required to adhere to applicable regulations pertaining to surface water quality, such as Louisiana Permitted Discharge Elimination System (LPDES) permitting. Structures neither raised nor demolished/removed face the risk of flooding and are capable of releasing constituents associated with structure and housed materials; for a local example of water quality impacts of flooded structures please see Skrobialowski et al. (2007).

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)
Direct impacts of ecosystem restoration features would convert existing open water, wetland, and low-quality chenier habitat to oyster reef, marsh, and improved chenier habitat, hydrologic structure, and shoreline protection features. Because rock, fill, and construction materials for proposed hydrologic/salinity control and shoreline protection features are anticipated to be free of contaminants, discharge of these materials into existing adjacent waters is not expected to result in adverse effects to aquatic organisms. Material proposed for construction of marsh and chenier restoration features would be evaluated to determine suitability for placement in the aquatic environment in accordance with Clean Water Act Section 404(b)(1). Construction of marsh habitat will cause negative, short-term impacts to water quality. The disturbance of bottom sediment resulting from the construction of earthen berms will probably result in a temporary increase in turbidity and nutrient concentration, and a temporary decrease in dissolved oxygen levels in the water column. Borrow from the CSC will be part of the existing maintenance events and will be the same as future without project conditions. The depths of borrow pits in the Gulf will be limited to the area of wave penetration. There is no expectation of low dissolved oxygen in the borrow pits due to designs that will control depth, shape and location in the existing wave/wind climate.

Indirect impacts regarding ecosystem restoration features could lead to water quality improvements through the restoration and protection of wetland and chenier habitat. Hydrologic/salinity control structures are expected to aid in reducing salinities in some regions of the study area, the benefits of which are largely unknown, as area wetlands have likely adapted to existing salinity patterns.

Alternative - Mermentau Small Integrated Restoration Plan
Impacts are the same as the MB component of the TSP.

2.3 Natural Environment

2.3.1 Sedimentation and Erosion

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)
There would be no direct or indirect impacts.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

- *Hydro/Salinity*: Hydro/salinity measure Calcasieu/Sabine Basin (CB) #74a is proposed as a spillway structure on the east side of Calcasieu Lake. The proposed action would evacuate storm surge from wetlands behind the Cameron-Creole levee. The measure would not be used to manage daily tidal exchange from

Calcasieu Lake. The structure dimensions are 204 feet wide by 600 feet long, and would directly impact approximately 3 acres of water bottoms in Calcasieu Lake. Sediment transport at the salinity control structure site would likely remain unaffected, as it would only be operational during storm surge events for increased drainage capacity for the Cameron-Creole Watershed. This would not affect sediment delivery to the coast. This water control structure would likely lead to minimal local reduced water levels landward of the Cameron-Creole levee through improved drainage from storm surge. The rock lining in the outfall channel would minimize increased erosion from operation.

- *Marsh Restoration*: Increased marsh surface area would increase sediment entrapment when marshes are flooded (e.g., tidal and storm surge). Restored marsh would reduce fetch over open water areas thereby reducing wind generated waves and subsequent erosion.
- *Shoreline Protection*: Sedimentation patterns in the vicinity of the features would be altered. Sediment deposition and/or erosion would occur depending on the hydrodynamics at the site. For example, the location and orientation of individual features could cause erosion and/or sediment accretion. Shoreline erosion adjacent to the features would likely be reduced. Longshore sediment transport in the vicinity of the shoreline protection features in the Gulf of Mexico may result in the accumulation of sediment behind breakwater features, creating salients or tombolos.
- *Cheniers*: Tree roots would likely reduce erosion of cheniers if they are overtopped due to storms or relative sea level rise by binding sediments together. Trees would likely reduce storm surge and subsequent erosion of adjacent marshes.

Alternative - Mermentau Small Integrated Restoration
Impacts are the same as the MB component of the TSP.

2.3.2 Soils, Water Bottoms, and Prime and Unique Farmlands

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)
Nonstructural component would have no direct impacts on soils, prime and unique farmlands, or water bottoms. However, a beneficial indirect impact through the acquisition of property in the event of a buyout of the structure could result in soils being returned to "green space" and soils that are prime and unique farmlands could become available for agriculture and use as pastureland (i.e., structures, including slab foundations, would be removed from the area).

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

- *Hydro/Salinity*: Hydro/salinity measure Calcasieu/Sabine Basin (CB) #74a is currently a spillway structure located on East Calcasieu Lake. The proposed action would evacuate storm surge waters from wetlands located behind the Cameron-Creole levee. The measure would not be used to manage daily tidal exchange from Calcasieu Lake. The structure dimensions are 204 ft wide by 600 ft in length, and would directly impact approximately 3 acres of water bottoms in Calcasieu Lake. The dredging of a floatation canal would directly impact 104 acres of water bottoms, but the impacts would be temporary as the canals would be refilled at the completion of use in accordance with standard best management practices. Table 2-16 NER Alternative Plan Features (Chapter 2) provides a full listing of feature with quantities. Bancker and Clovelly muck hydric soils are most common in the wetlands located behind the Cameron-Creole levee, as well as along the East Calcasieu Lake shore. The use of the proposed spillway channel to control or remove storm surge flood waters from the wetlands could slow or prevent further erosion and provide a beneficial impact to hydric soils and wetlands adjacent to East Calcasieu Lake. The closest identified soils to East Calcasieu Lake and the proposed H/S #74a measure that are classified as prime farmlands consist primarily of Hackberry loamy fine sand (Hb) and Judice silty clay loam (Ju) on chenier ridge tops. Prime farmlands would not be directly impacted by the construction or use of the spillway channel, but could benefit indirectly by the prevention of future soil and land losses attributed to storm surges.
- *Marsh Restoration*: These marsh restoration features would include the beneficial use of dredged material from the Calcasieu Ship Channel and the Gulf of Mexico (Gulf) for the restoration and nourishment of marsh. Hydric soils in the marsh restoration areas consist primarily of Bancker muck, Creole mucky clay, Scatlake mucky clay, Larose mucky clay; and less frequently Allemands mucky peat, Clovelly muck, and Mermentau clay (Table 2-2).

Table 2-2: Hydric soils in marsh restoration areas.

Soil Association	Acres
Allemands mucky peat (AE)	40
Bancker muck (BA)	4,747
Clovelly muck (CO)	142
Creole mucky clay (CR)	3,481
Larose mucky clay (LR)	503
Mermentau clay (MM and ME)	24
Scatlake mucky clay (SC)	1,327

Impacts to hydric soils from the restoration and nourishment of marsh would be beneficial. As marsh is restored, hydric soils would increase and become more stable. Direct impacts to water bottoms in the marsh restoration footprints (Calcasieu Basin over 6,000 acres and Mermantau Basin over almost 6,550 acres created or nourished), containment dikes, floatation canals and borrow areas would result in the loss of existing bottom habitat. The containment dikes would naturally degrade over time, resulting in the temporary loss of approximately 359 acres of bottom habitat. Borrow areas to provide sediment for the restoration and nourishment of the marsh areas would result in direct impacts to approximately 7,000 acres of bottom habitat.

Soils associated with prime and unique farmlands are most common on chenier ridges, and none of these soils were identified in the marsh restoration areas. There would be no direct impacts to prime and unique farmlands as a result of the restoration and nourishment of marsh areas. The restoration and nourishment of marsh could result in an indirect impact that could be beneficial to soils identified as prime and unique farmlands. The restoration of marsh would contribute to flood attenuation from small storm events and could prevent future loss of prime and unique farmland soils that may be present on nearby chenier ridges.

- *Shoreline Protection*: The 5a: Holly Beach Shoreline Stabilization – Breakwaters measure would include placement of rock breakwaters, resulting in direct impacts to water bottoms in the Gulf of Mexico. The Gulf Shoreline Restoration: Calcasieu River to Freshwater Bayou measures (6b1, 6b2, and 6b3) would be constructed in three segments, resulting in direct impacts to water bottoms in the Gulf of Mexico. Measure 16b: Fortify Spoil Banks of GIWW and Freshwater Bayou would consist of bankline protection with rock dikes along three separate reaches of Freshwater Bayou, resulting in direct impacts to water bottoms in Freshwater Bayou. In all shoreline protection measures, soft surface water bottoms would be replaced with rock resulting in indirect impacts to aquatic habitat along the shorelines. The dredging of floatation canals and associated disposal areas would result in temporary direct impacts to 4,042 acres of bottom habitat. Hydric soils could be directly impacted during the placement of stone breakwaters and rock dikes, but long term indirect impacts would include the prevention of further erosion and loss of these soils, and potentially an increase in hydric soils along the Gulf shoreline. Table 2-18b (Chapter 2) provides a full listing of each feature with quantities. Soils associated with prime and unique farmlands are most common on chenier ridges, and none of these soils were identified in the vicinity of the Gulf shoreline restoration or Freshwater Bayou features. Approximately 549 acres of Hackberry loamy fine sand, classified as a prime farmland soil, is located along the shoreline adjacent to the Holley Beach shoreline stabilization feature. The 549 acres of prime farmland soils along the shoreline at Holley Beach would not be directly impacted by the placement of the rock breakwaters, nor would any other prime and unique farmlands be directly impacted or removed from agriculture use by the shoreline protection feature of the TSP. Indirect impacts to the 549 acres of Hackberry loamy fine sand resulting from the shoreline stabilization feature at Holley Beach would include a reduction in erosion and loss of the prime farmlands.
- *Cheniers*: A total of 578 acres of hydric soils (Table 2-2) were identified along the cheniers. Reforestation of the cheniers would stabilize soils and could prevent future erosion and loss of hydric soils. Therefore, the direct and indirect impacts to hydric soils on the cheniers would be beneficial. No water bottoms were identified on the cheniers, so there would be no direct or indirect impacts to water bottoms as a result of chenier reforestation. Soils that are suitable for agriculture and pastureland in the Chenier Plains are most commonly located on the chenier ridges. Approximately 514 acres of soils classified as prime farmlands, consisting entirely of Hackberry loamy fine sand, are present along the chenier ridges that are proposed for

reforestation under this alternative. The reforestation of the chenier ridges would remove these areas and identified prime farmlands from future agricultural use. In compliance with the Farmland Protection Policy Act (FPPA), the USACE consulted with the Department of Agriculture – Natural Resources Conservation Service (NRCS) to determine the precise acreage of prime and unique farmlands that would be impacted. It was determined that the proposed activities would not irreversibly impact prime farmlands and is exempt from the rules and regulations of the FPPA, Subtitle I of Title XV, Section 1539 – 1549 (NRCS letter dated December 13, 2013). Table 2-18c (Chapter 2) provides a full listing of feature quantities.

Alternative - Mermentau Small Integrated Restoration Plan
Impacts are the same as the MB component of the TSP.

2.3.3 Coastal Shorelines

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan
No impacts as the NED areas are located far removed from the Gulf coastal shoreline.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

- *Hydro/Salinity*: No impacts.
- *Marsh Restoration*: Only measure 124c: Marsh Creation at Mud Lake would occur in proximity to the Gulf shoreline. Construction of this measure would require dredged material to be pumped across the shoreline from the Gulf borrow site to the marsh restoration sites resulting in only temporary and minor disturbance to the shoreline resources expected from this construction activity.
- *Shoreline Protection*: Proposed segmented breakwaters are expected to eliminate or substantially reduce erosion of the gulf shoreline, but would not directly affect hydrology or salinity levels since the openings between the breakwater segments would allow free passage of water. Indirectly, the breakwaters would maintain existing salinity and hydrology in the marshes and water bodies behind the shoreline, which could otherwise be altered by continued erosion. In the MB there are numerous canals and natural bayous and ponds that lie behind the gulf shoreline. Gulf Shoreline Restoration: Calcasieu River to Freshwater Bayou measures (6b1, 6b2, and 6b3) would prevent new openings from forming between the Gulf and these water bodies.
- *Cheniers*: Several of the chenier restoration projects would occur in close proximity to the Gulf shoreline. It is possible that some construction equipment may be delivered by barge from the Gulf to access the chenier ridges to perform restoration activities. In such cases, there would be minor, localized, temporary adverse impacts, including loss of vegetation cover and displacement of shoreline sediments.

Alternative - Mermentau Small Integrated Restoration
Direct and Indirect Impacts: Impacts same as MB impacts of TSP.

2.3.4 Vegetation Resources

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)
The 0-25-year floodplain within the area identified as the nonstructural component of the TSP would not significantly impact existing vegetation resources as any construction would be to previously disturbed areas. There is a risk that certain methods at certain locations could impact wetlands on that site but these methods and locations combinations would be avoided where practicable.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)
The TSP would restore/nourish/protect acreage in the CB and the MB.

- *Hydro/Salinity*: Measure #74a in the CB would provide benefit to existing wetlands through the evacuation of wetland-damaging storm surge-deposited water from behind the Cameron-Creole levee during storm events. However, this measure is not anticipated to affect daily tidal exchange from Calcasieu Lake. This measure would indirectly benefit vegetation by reducing the exposure to higher salinity waters associated

with storm surge that overtops the Cameron-Creole levee, thereby providing for a more stable system. Table 2-18b (Chapter 2) provides a full listing of each feature with quantities.

- *Marsh Restoration*: These measures would restore and/or nourish saline marsh and brackish marsh in the CB and brackish marsh in the MB. Saline marsh and brackish marsh would be impacted in the CB, and brackish marsh would be impacted in the MB from access required for borrow deposition. Table 2-18a (Chapter 2) provides a full listing of each feature with quantities. Restored/nourished marsh would contribute to reducing the overall habitat fragmentation in the area as well as provide many different species of fish and wildlife with shelter, nesting, feeding, roosting, cover, nursery, and other life requirements habitat. These marsh habitats will also provide neotropical migrants with essential staging and stopover habitat (after Stoffer and Zoller 2004, Zoller 2004). Based on previous coastal restoration actions, it is expected that invasive species would not occur on restored coastal marsh platforms unless the elevation of the marsh platform is too high (i.e., upland-like conditions). Implementation of hydro/salinity measures could result in a conversion of some existing marsh types to a fresher marsh type over time. Table 2-18a (Chapter 2) provides a full listing of each feature with quantities.
- *Shoreline Protection*: These measures would protect barrier island habitat in the CB, and saline marsh and brackish marsh in the MB. These shoreline protection measures would restore an important geomorphic framework for preventing further fragmentation and loss of interior wetlands used as habitat by many different species of fish and wildlife. Table 2-18b (Chapter 2)provides a full listing of each feature with quantities.
- *Cheniers*: Measures would provide reforestation of Chenier forests and improve habitat in the CB habitat in the MB. Table 2-18b (Chapter 2)provides a full listing of each feature with quantities. The proposed reforestation would provide critical stopover habitat for migratory neotropic birds. Typical invasive plants that may be eliminated or controlled but are not limited to this list are Chinese tallow, Chinese privet, cogon grass, Johnsongrass, Japanese privet, Japanese honeysuckle, common ragweed, rescuegrass, sticky chickweed, purple nutsedge, and mimosa trees. However, invasive species are presently limited on the cheniers due to ongoing farming activities.

Alternative - Mermentau Small Integrated Restoration
Impacts are the same as the MB component of the TSP.

2.3.5 Wildlife Resources

HSDRR (NED) Plans

Alternative - Nonstructural Plan (TSP)
No significant impacts on most wildlife resources except for human commensal wildlife (e.g., rats, mice, pigeons, etc.) that thrive in association with human habitations, which typically disrupt the natural habitats. There could be possible benefits to wildlife if enough structures on land contiguous with each other were bought out and allowed to return to a natural state and if that area was contiguous with an adjacent wildlife corridor.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

- *Hydro/Salinity*: The loss of fresh marsh attributed to salinity intrusion from daily tidal movement as projected within areas controlled by the proposed structure (measure 74a) would be reduced, helping to preserve the existing marsh in the area and the wildlife populations dependent on this habitat type. No wildlife impacts are anticipated from installation of this structure.
- *Marsh Restoration*: Open water would be converted to brackish marsh and saline marsh in the CB, and open water would be converted to brackish marsh in the MB. Table 2-18b (Chapter 2)provides a full listing of each feature with quantities. Additional nourishment could occur adjacent to the marsh restoration sites. The proposed restoration/nourishment in these basins would result in improved habitat conditions for several species of wildlife including migratory and resident waterfowl, shorebirds, wading birds, and furbearers. Migratory waterfowl utilizing the area would benefit from a greater food supply resulting from the increased abundance and diversity of emergent and submerged species. Habitat for the resident mottled duck would also improve considerably as the marsh platform would provide more desirable nesting habitat. Intertidal marsh and marsh edge would also provide increased foraging opportunities for shorebirds and wading birds. Small fishes and crustaceans are often found in greater densities along vegetated marsh edge (Castellanos and

Rozas 2001, Rozas and Minello 2001), and many of those species are important prey items for wading birds such as the great blue heron, little blue heron, great egret, black-crowned night-heron, and snowy egret. Mudflats and shallow water habitat restored by the deposition of dredged material would provide increased foraging opportunities for shorebirds such as least sandpipers, killdeer, and the American avocet. Those species feed on tiny invertebrates and crustaceans found on mudflats which are exposed at low tide and in shallow-water areas of the appropriate depth. Furbearers (such as nutria and muskrat) which feed on vegetation would benefit from the increased marsh acreage in the project area. Representative furbearers such as the mink, river otter, and raccoon have a diverse diet and feed on many different species of fishes and crustaceans. Those species often feed along vegetated shorelines which provide cover for many of their prey species. The loss of open water habitat with construction of these features would not be expected to adversely affect species that currently utilize these habitats as there is ample open water habitat in the basins. Wildlife species currently utilizing the shallow open water and vegetated shorelines in the project area are highly mobile and/or suited to semi-aquatic life and should not be affected during construction.

- *Shoreline Protection*: The installation of segmented offshore breakwaters and rock revetment would work to protect the marshes behind these structures from wave induced erosion and help maintain wildlife populations dependent on this habitat type. Some habitat would be lost during installation of the rock revetment reducing the available habitat for wildlife species and resulting in the demise of more immobile wildlife species. However, these impacts would result in a minimal overall impact to wildlife populations in the area and would work to protect the adjacent habitat these species depend on for survival that could be lost in the future if the revetment was not installed. Table 2-18b (Chapter 2) provides a full listing of each feature with quantities.
- *Cheniers*: Existing Chenier habitat in the CB and the MB would undergo invasive species control and reforestation with construction of the proposed action. Table 2-18b (Chapter 2) provides a full listing of each feature with quantities. Implementation of these measures would increase the diversity of the existing habitat and the quality of the available foraging, resting and nesting habitat necessary for numerous terrestrial and avian wildlife species and essential for neotropical migrants. Construction would be minimally invasive (no earthwork is required) and some species may temporarily avoid these project features during construction, but would quickly return once construction is complete.

Alternative - Mermentau Small Integrated Restoration

Impacts to wildlife resources would be similar to those discussed for the NER TSP except to a lesser extent.

2.3.6 Fisheries and Aquatic Resources

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)

The nonstructural features should have no impact to these resources depending on the methods used. Direct and indirect impacts to these resources will be refined when the actual method of nonstructural and number of structures are examined in future NEPA documents.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

- *Hydro/Salinity*: The CB component (#74a) as presently described would convert open water benthic habitat and marsh into a rock structure, part of this structure would be out of the water and would be completely unavailable for fisheries use. The majority of the open water area is now listed as public oyster seed ground. Table 2-18b (Chapter 2) provides a full listing of each feature with quantities. Direct effects on benthic habitat from the measure includes covering and smothering of benthic organisms including oysters by the placement of rock. During construction of project features, there would be short-term indirect adverse impacts to plankton, benthic populations and fisheries species due to increases in turbidity, low dissolved oxygen, and introduction of sediments into shallow open water areas. Filter feeding species would be impacted due to clogging of the gills which could either cause death or reduce growth and reproduction. Visual predators would have a reduced success rate due to turbidity. Mobile species would attempt to move from the area of influence.
- *Marsh Restoration*: Impacts in the construction footprint, and construction activities using earthen materials to create wetland could include the elimination of benthic, oyster, and fishery habitat or the conversion of shallow open water habitats to less valuable deep water borrow areas, and direct mortality or

injury of fisheries and benthic species due to burial or increased turbidity. Borrow areas are identified from Calcasieu Ship Channel, and the Gulf of Mexico. Table 2-18a (Chapter 2) provides a full listing of each feature with quantities. Depending on the depth of the borrow area this deeper water habitat could provide a refuge for fisheries and benthic species during extreme water temperature spikes. Improved marsh habitats and increased SAV could have positive indirect impacts on juvenile fishes, shrimp, crabs, and other species by increasing food and cover if they are able to access the area. The two main limiting factors in SAV colonization are depth and turbidity, not seed source. When marshes are restored the shallow open water that is left is more conducive for SAV colonization due to the shallower depth. Also due to the marsh the fetch is reduced so turbidity is reduced thus the likelihood of SAV colonization. The conversion of open water to marsh is generally considered a benefit to aquatic species.

- *Shoreline Protection*: Impacts in the construction footprint would include the elimination of benthic, oyster, and fishery habitat and would cause the conversion of sandy shallow open water habitats to rock habitat which will only partially be submerged. Additionally shallow mud bottom would be converted to rock with the MB components in the GIWW and Freshwater Bayou. Table 2-18b (Chapter 2) provides a full listing of each feature with quantities. During construction of project features, there would be short-term indirect adverse impacts to plankton, benthic populations and fisheries species due to increases in turbidity, and low dissolved oxygen. Filter feeding species would be impacted due to clogging of the gills which could either cause death or reduce growth and reproduction. Visual predators would have a reduced success rate due to turbidity. Mobile species would attempt to move from the area of influence. Rock substrate is known to provide benefits to some aquatic species by providing them a refuge from predation. They also provide a hard substrate for oyster spat to settle on.
- *Cheniers*: Reforestation of the Chenier ridges would have no direct, indirect or cumulative impacts on these resources.

Alternative - Mermentau Small Integrated Restoration Plan
Impacts are the same as the MB component of the TSP.

2.3.7 Essential Fish Habitat

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)
No significant impact to these resources is expected. There is a risk that certain methods at certain locations could impact wetland EFH on that site but these methods and locations combinations would be avoided where practicable.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

- *Hydro/Salinity*: Measure #74a in the CB would directly impact water bottom EFH by converting it into rocky bottom and marsh EFH into a rock structure. Rock is not considered EFH in coastal Louisiana. Table 2-18b (Chapter 2) provides a full listing of each feature with quantities.
- *Marsh Restoration*: Both the CB and MB components would convert open water (combination of estuarine mud bottoms and oyster reefs EFH) to marsh (marsh edge, SAV, marsh ponds, and inner marsh EFH). Table 2-18b (Chapter 2)provides a full listing of each feature with quantities. Construction activities using earthen materials to create marsh could bury EFH substrates or temporarily change environmental conditions, including turbidity and salinity, in the water column. The project would increase SAV and adjacent intertidal marsh vegetation (marsh restoration areas) in some areas. However, increases in SAV colonization would be limited by depth and turbidity, not seed source. When marshes are restored the shallow open water that is left is more conducive for SAV colonization due to the shallower depth. Also due to the marsh the fetch is reduced so turbidity is reduced thus the likelihood of SAV colonization. The CB components and MB components will nourish existing marshes and terraces. This will be a long term indirect positive impact to marsh (marsh edge, SAV, marsh ponds, and inner marsh EFH). Borrow areas are identified from Calcasieu Ship Channel and the Gulf of Mexico for the CB, and from the Gulf of Mexico for the MB. If the dredged material coming from the ship channel is obtained during a maintenance event there would be no additional impacts to EFH. Borrow from the Gulf would convert Gulf water EFH to a deeper depth Gulf water EFH. Some of the offshore borrow areas could refill with material overtime. Table 2-18b (Chapter 2) provides a full listing of each feature with quantities.

- *Shoreline Protection*: Both the CB and MB components would convert open water (combination of estuarine mud bottoms, oyster reefs, Gulf waters, marsh edge, offshore, beach, coastal, and sand EFH) to rock, which is not considered EFH in coastal Louisiana. Table 2-18b (Chapter 2) provides a full listing of each feature with quantities.
- *Cheniers*: Reforestation of the Chenier ridges would have no direct, indirect or cumulative impacts on EFH.

Alternative - Mermentau Small Integrated Restoration Plan
Impacts are the same as the MB component of TSP.

2.3.8 Threatened and Endangered Species and Other Protected or Species of Concern

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)
This alternative would have no effect on the red-cockaded woodpecker (RCW) or any species of concern within the project area. Direct impacts would be avoided in accordance with the Endangered Species Act (ESA), Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act by the use of best management practices (BMPs) (see appendix A) and recommendations from USFWS. Depending on final designs of the NED TSP, potential minimal indirect impacts could occur to the candidate species, Sprague's pipit. These impacts could include the temporary displacement of any birds that may be present due to construction activity and noise. However, impacts to this species would be avoided, minimized and reduced to the maximum extent practicable and mitigated as necessary.

Species of Concern: Depending on final designs of the NED TSP, there could be a potential for minimal indirect impacts to colonial nesting water birds. These impacts could include the temporary displacement of any birds that may be present due to construction activity and noise. It is assumed the birds would relocate to adjacent foraging/roosting grounds. Nesting birds would not be impacted as no work would take place within a rookery. Additionally, during nesting season, work would be required to take place outside of the USFWS and LDWF-declared buffer zones (Appendix A Annex K). Work within the buffer zones may only take place during non-nesting season (September 1 to February 15). There would be no impacts to the bald eagle as no known nests are located near any project features. If an eagle's nest is found within the project area, a no-work zone would be implemented (Appendix A Annex K).

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)
Based on review of existing data, it is the opinion of CEMVN that implementation of this alternative is not likely to adversely affect the piping plover and piping plover critical habitat, red knot, West Indian manatee, Gulf sturgeon, loggerhead and Kemps Ridley sea turtles; and would have no effect on the green, leatherback, and hawksbill sea turtles or loggerhead critical habitat or other species of concern. Direct impacts would be avoided in accordance with the ESA, BGEPA, MMPA and MBTA by the use of BMPs (appendix A annex K) and recommendations from USFWS and NMFS. All indirect impacts would be avoided, minimized and reduced to the maximum extent practicable and mitigated as necessary. Further consultation would occur as this project moves forward.

- *Hydro/Salinity*: No anticipated impacts to T&E.

Marsh Restoration: Potential temporary minimal indirect impacts to the West Indian manatee, Gulf sturgeon and all sea turtles identified in Appendix A, Annex K. Temporary construction related impacts would result from noise, turbulence and the mere presence of workers in the marsh restoration sites, access routes and borrow sites and would likely result in the species avoiding the area temporarily. In addition critical habitat for piping plover will be temporarily impacted by the dredge pipeline coming in from the Gulf where it crosses the beach. Loggerhead critical habitat would not be impacted as the borrow sites are within approximately 3 miles offshore. Beneficial impacts would be the increase in wetland habitat which is utilized by the Whooping crane. Table 2-18a (Chapter 2) provides a full listing of each feature with quantities.

- *Shoreline Protection*: Potential Indirect impacts to the West Indian manatee, Gulf sturgeon and all sea turtles listed in Appendix A Annex K would be temporary and minimal. Temporary construction related impacts would be due to noise, turbulence and mere presence of workers in the marsh restoration sites, access routes and borrow sites and would likely result in the species avoiding the area temporarily. Permanent impacts

would be the hindrance of access by sea turtles, to thousands of linear feet of shoreline. However, sea turtles do not typically use the beaches of Louisiana and it is assumed that they could easily go around the breakwater as it would not be contiguous.Loggerhead critical habitat would not be impacted as the shoreline protection features are approximately 150 feet from the shore. Indirect beneficial impacts would be the protection of thousands of linear feet of shoreline which is designated piping plover critical habitat and also used by the Red knot. Table 2-18b (Chapter 2) provides a full listing of each feature with quantities.

- *Cheniers*: There could be potential minimal indirect impacts to the Sprague's pipit if reforestation of grasslands would occur. It is assumed that the birds would relocate to an adjacent or nearby suitable foraging/roosting area. Table 2-18c (Chapter 2) provides a full listing of feature quantities.

Species of Concern:

- Potential for minimal indirect impacts to colonial nesting water birds. Impacts could include disturbance of roosting or foraging birds due to construction activity and noise. It is anticipated nesting birds would not be impacted as no work would take place within a rookery. Additionally, during nesting season, work would be required to take place outside of the USFWS and LDWF declared buffer zones (Appendix A, Annexes K & Q). Work within buffer zones may only take place during non-nesting season (September 1 to February 15). In addition to these potential adverse impacts, marsh restoration would beneficially impact colonial nesting water birds by providing additional foraging grounds.
- No impacts to the bald eagle, as no known nests are located near any project features. If an eagle's nest is found within the project area, a no-work zone must be implemented.
- Bottlenose dolphins could be found in the vicinity of these project features, but with the utilization of the measures for reducing entrapment of this species found in Appendix A, Annexes K & Q, no indirect impacts are anticipated.

Alternative - Mermentau Small Integrated Restoration Plan

Impacts to T&E resources would be similar to those discussed for the NER TSP except to a lesser extent.

2.3.9 Historic and Cultural Resources

The following alternatives have the potential to impact cultural resources, and CEMVN has determined that additional investigations would be required prior to the implementation of the recommended plans in order to assess potential impacts to historic properties. The CEMVN will seek to identify ways to avoid, minimize, and/or mitigate impacts from the proposed action to historic properties and resources of religious and cultural significance to Tribes. The USACE has elected to fulfill its obligations under Section 106 of the NHPA through the execution and implementation of a Programmatic Agreement as provided in 36 CFR Part 800.14(b). Information provided below is detailed in the *Cultural Resources Assessment and Research Design for the Southwest Coastal Louisiana Project, Calcasieu, Cameron, Iberia, Jefferson Davis, and Vermilion Parishes, Louisiana* (Wells and Hill 2014) on file with the Louisiana Division of Archaeology.

HSDRR (NED) Plan

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)

There is the potential for direct and indirect impacts to previously recorded archaeological sites and standing structures with a minimum age of 50 years, as well as any unrecorded sites and/or standing structures that may be identified during the cultural resource investigation.

Approximately 4,952 standing structures located within the 0-25 year flood plain have been identified as candidates for nonstructural measures. Although specific structures have not been selected for nonstructural measures, there remains the possibility that the standing structures identified as potential candidates have a minimum age of 50 years and have not been assessed for eligibility. Sixteen historic properties have been identified in the study area, including 12 that are listed in the National Register of Historic Places (NRHP).

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

Calcasieu Basin - There is the potential for direct and indirect impacts to 17 standing structures with a minimum age of 50 years that have not been assessed for eligibility, as well as any unrecorded sites and/or standing structures that may be identified during the cultural resource investigation. The previously recorded

sites include one potentially eligible for listing in the NRHP and four that have been determined not eligible for listing in the NRHP. The remaining 13 have not been assessed. Of the 18 previously recorded sites, 13 have prehistoric components, and six have historic components.

- *Hydro/Salinity*: No previously recorded sites or standing structures have been identified within a one-mile buffer of the proposed measure (#74a).
- *Marsh Restoration*: One prehistoric site of unknown eligibility has been identified within a one-mile buffer of the proposed measures (3a1, 3c1, 124c, and 124d). No previously recorded standing structures have been identified within a one-mile buffer of the proposed measures. No previously recorded sites have been identified within the proposed borrow areas.
- *Shoreline Protection*: One historic site that has been determined not eligible for listing in the NRHP has been identified within a one-mile buffer of the proposed measure (5a). Four previously recorded standing structures within the one-mile buffer have a minimum age of 50 years and have not been assessed for eligibility.
- *Cheniers*: Two prehistoric sites, one with a historic component, and four historic sites have been identified within a one-mile buffer of the proposed measures (510a, 510b, and 510d), none of which have been assessed for eligibility for listing in the NRHP and three that have been determined not eligible for listing in the NRHP. The remaining 12 have not been assessed. Forty-four previously recorded standing structures within the one-mile buffer have a minimum age of 50 years and have not been assessed for eligibility.

Mermentau Basin - There is the potential for direct and indirect impacts to 19 previously recorded archaeological sites and 31 standing structures with a minimum age of 50 years that have not been assessed for eligibility, as well as any unrecorded sites and/or standing structures that may be identified during the cultural resource investigation. The previously recorded sites include one potentially eligible for listing in the NRHP and seven that have been determined not eligible for listing in the NRHP. The remaining 20 have not been assessed. Of the 19 sites, all have prehistoric components, and one has historic components.

- *Marsh Restoration*: Nine prehistoric sites have been identified within a one-mile buffer of the proposed measures (47a1, 47a2, 47c1, 127c3, and 306a1), one of which has been identified as potentially eligible for listing in the NRHP and two that have been determined not eligible for listing in the NRHP. The remaining six have not been assessed. Sixteen standing structures within the one-mile buffer have a minimum age of 50 years and have not been assessed for eligibility. No previously recorded sites have been identified within the proposed borrow areas.
- *Shoreline Protection*: Eight prehistoric sites have been identified within a one-mile buffer of the proposed measures (16b, 6b1, 6b2, and 6b3), four of which have been determined not eligible for listing in the NRHP. The remaining four have not been assessed. No previously recorded standing structures have been identified within a one-mile buffer of the proposed measure.
- *Cheniers*: Eleven prehistoric sites, one with a historic component has been identified within a one-mile buffer of the proposed measures (416, 509c, and 509d), one of which has been identified as potentially eligible for listing in the NRHP and three that have been determined not eligible for listing in the NRHP. The remaining seven have not been assessed. Thirty-one standing structures within the one-mile buffer have a minimum age of 50 years and have not been assessed for eligibility.

Alternative - Mermentau Small Integrated Restoration

Impacts would be the same as those described for the MB component of the TSP.

2.3.10 Aesthetics (Visual Resources)

HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)

Minimal impacts to visual resources. The raising of homes would not impact view sheds into any surrounding areas. In cases where a home or land buyout may be taking place this could indirectly impact visual resources by removing the viewer from a given area. In areas where there is public access from a street or roadway, these non-structural elements would not change the view shed. Houses being raised are currently present, their elevation would change, but the site is still occupied either way. In the case of a home buyout, if a home is removed and open land is created, then this could be considered as a benefit to drivers looking for natural scenery or a loss to an established neighborhood.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

- *Hydro/Salinity*: In terms of technical significance, reducing the residence time of saline water and increasing wetland productivity would most certainly benefit visual resources. In areas influenced by this measure, marshes would improve in quality relative to the Future Without Project condition, better maintaining the texture, color and framing elements of the landscape. Greater habitat diversity would be preserved, supporting a greater variety of fauna to the given area to serve as focal points of life. In terms of public and institutional significance, the measures associated with hydro/ salinity will positively benefit areas in Cameron Parish along the Creole Nature Trail Scenic Byway and All American Road. Those areas project designated areas along LA-27 and LA-82 will be directly visible to those travelling the scenic byway.
- *Marsh Restoration*: This element would not be all that different from the definitions listed under Hydro/ Salinity. The areas of significance, in terms of what Hydro/ Salinity goals are meant to achieve, are almost exactly the same as they relate to Visual Resources. The primary difference is in how the marsh is restored. With the use of beneficial use dredge material from Calcasieu Ship Channel, where impacts will be minimal, visual resources will be greatly and positively impacted. Those areas along the Creole Nature Trail will positively impact the byway creating enhanced view sheds for travelers. Other areas, such as that located along the Intracoastal waterway and Freshwater Bayou Canal have less visual significance because those areas are remote with limited access. Construction of marsh habitat may have temporary negative impact to the Aesthetic resources in the project area. Initial construction of the marsh will temporarily alter open water to bare mud flats, which may be considered aesthetically unpleasant. With dewatering and natural colonization of marsh plants, it will take approximately five years before the marsh becomes established with vegetation.
- *Shoreline Protection*: These elements do have public visual significance and their protection and restoration would add an element of form, line and color to the shoreline of Louisiana. Visually, manmade measures like breakwaters would not have positive effects on the viewscape of undeveloped and natural beach. Measures such as this are necessary to ensure that the beach remains as it is. Many of these areas are remote and public access is very limited.
- *Cheniers*: Visually, these features are the most significant of any other in the study area. Cheniers aid in the form and function of developing the design elements of the landscape. As small hillocks or ridges, they offer the variation in terrain that makes the view shed interesting and memorable. They offer islands of oasis for different plant materials to develop and add texture and color to the land. In most cases, they allow taller trees to grow in a region which adds the necessary framing elements to the landscape to give it artistic quality and character. Most of the designated chenier restoration features are located directly adjacent to the Creole Nature Trail and would drastically and positively add to design elements already described under marsh restoration and hydro/ salinity.

Alternative - Mermentau Small Integrated Restoration

Impacts would be the same as those described for the MB component of the TSP.

2.3.11 Recreation – See Recreation Annex N

2.4 Cumulative Impacts

2.4.1 HSDRR (NED) Plans

Alternative - Nonstructural 0-25 Year Floodplain Plan (TSP)

The direct and indirect incremental impacts of implementing the Nonstructural Plan on valued environmental components, or significant environmental resources, determines if cumulative effects need to be addressed (USACE 2007) utilizing CEQ's 11-step cumulative effects analysis process (CEQ 1997). Cumulative impacts are the incremental direct and indirect effects on each significant human and natural resource identified above, caused by elevating 3,665 residential structures, flood proofing 247 non-residential structures and acquiring 3 residential structures for acquisition. These incremental impacts would be in addition to the direct and indirect impacts attributable to other existing and authorized for construction levee systems throughout the Sabine, Calcasieu, Mermentau and Teche- Vermilion basins; the State and the Nation. The proposed action incremental effects would be in addition to the State's approximately 3,122 miles of levee (source: http://www.infrastructurereportcard.org/louisiana/louisiana-overview/); and the approximately 100,000 miles of levees which exist throughout the Nation (source: http://www.infrastructurereportcard.org/levees/).

- Consistent with Step 1 of the CEQ 11-step process, this report identifies in previous sections the potential significant direct and indirect effects and issues associated with implementing the proposed nonstructural risk reduction plan on significant human and natural resources. Generally, there would be no significant direct or indirect effects on the natural environment. Rather, most effects would be on the human environment as described in preceding sections.
- Consistent with CEQ step 2, this report identifies the geographic scope of the analysis as the area consisting of Calcasieu, Cameron, and Vermilion Parishes; additionally, the report characterizes the affected resources.
- Consistent with CEQ step 3, this report identifies the time frame by describing in previous sections the historic, existing, future without project and future with project conditions for the identified significant natural and human environmental resources.
- Regarding CEQ step 4, other actions potentially affecting the significant natural and human resources in the area as well as Louisiana and the Nation include:

a. The American Society of Civil Engineers (http://www.infrastructurereportcard.org/) rates America's public infrastructure as a report card with performance rated as D^+ and an estimated investment needed by 2020 of $3.6 trillion. Among this infrastructure approximately 3,122 miles of levees within Louisiana (source: http://www.infrastructurereportcard.org/louisiana/louisiana-overview/); and approximately 100,000 miles of levees which exist throughout the Nation (source: http://www.infrastructurereportcard.org/levees/). However, the reliability of these levees is unknown and the country has yet to establish a National Levee Safety Program. Public safety remains at risk from these ageing structures, and the cost to repair or rehabilitate these levees is roughly estimated to be $100 billion by the National Committee on Levee Safety.

- Consistent with CEQ steps 5 and 6, response to change has been documented for each identified significant human and natural resource in previous sections. In addition, the stressors potentially affecting significant human and natural resources, and if appropriate, their relationship to regulatory thresholds have also been identified (e.g., air quality and water quality standards; factors for managing and identifying cultural resources; the age (50 years) and other requirement for eligibility to be considered for the national register of historic structures have also been identified). This latter example is of particular concern considering the 50-year period of analysis due to the potential numerous structures in the area which may qualify as a historic or national register structure over the period of analysis. With regard to their capacity to withstand stresses affecting the human environment, the recent Hurricane Rita (2005) and Ike (2008) caused significant damage to both the human and natural environmental resources. The human impacts of preparing for, mitigating, and recovering from these damages has placed a significant economic, physical, and emotional burden on both individuals and communities. According to the Louisiana Recovery Authority's 2006 "The Rita Report", the devastation Hurricane Rita left behind made it the third most expensive natural disaster in US history (source: http://lra.louisiana.gov/assets/docs/searchable/reports/RitaReportFinal091806.pdf). About 98 percent of oil and natural gas production in the gulf was halted as workers evacuated. The Rita Report estimated almost $600 million dollars of damage to agriculture, forestry and fishing.
- Consistent with CEQ step 7, the baseline condition has been documented for each significant human and natural resource including the historic, existing and future without project conditions (Chapter 1). Generally, current trends in the human environment such as employment, business and industrial activity, and community and regional growth tend to mirror the increases demonstrated in populations and housing. Only Cameron Parish has had a population decline.
- Consistent with CEQ step 8, the most important cause and effect relationships between human activities and resources, ecosystems and human communities have been addressed in previous sections by identifying the direct and indirect impacts of the proposed action on significant human and natural resources. The Conceptual Ecological Model (CEM) provides a network diagram which identifies and illustrates connections and inter-relationships among the area's major drivers. The CEM was used throughout the plan formulation process.
- With regard to CEQ step 9, the magnitude and significance of cumulative effects associated with implementing the nonstructural measures are primarily related to providing the incremental risk reduction achieved by elevating 3,665 residential structures, flood proofing 247 non-residential structures and acquiring 3 residential structures. These impacts would be in addition to other infrastructure risk reduction measures such as those described in the American Society of Civil Engineers Report Card of America's public infrastructure (http://www.lasce.org/documents/LouisianaInfastructureReportCard2012.pdf). Louisiana's

levee system is rated C- and has more than 2,800 miles of levees that are critical to protecting the residents and economy of the state from flood events. Of these, approximately 2,500 miles are river levees, while about 365 miles are hurricane protection levees. More than 19,000 square miles of land area is protected by these structures. The levees are managed by 27 levee districts with members appointed by the governor and Louisiana Legislature. The districts are funded by local property tax assessments for O&M of the systems. District personnel work closely with the USACE, the Louisiana Department of Transportation and Development (LADOTD), the Coastal Protection and Restoration Authority (CPRA), and others. The state funded flood control program and capital outlay program provide approximately $18 million to $30 million dollars annually. Federal funds appropriated by Congress directly to the USACE for Corps operations and construction total about $220 million annually.

- Consistent with CEQ step 10, during plan formulation the alternatives were modified, removed and new alternatives added to avoid, minimize and reduce potential significant project-induced effects. For example several structural levees were considered but were later screened out due to a failure of benefits to exceed costs. When considered incrementally with other risk reduction efforts the state of Louisiana still owes the federal government about $1.3 billion for its share of the construction costs of the New Orleans HSDRRS system. The State has already paid about $300 million and has an agreement to pay the rest over the next 30 years. In addition, many levees outside of the New Orleans area are still below the 100-year level of risk reduction and do not meet current design standards (http://www.lasce.org/documents/LouisianaInfastructureReportCard2012.pdf).
- With regard to CEQ step 11—monitoring effects of the proposed action and adaptation of management: an Adaptive Management and Monitoring Plan is included in appendix A annex L. Generally, the NED components of implementing nonstructural risk reduction would be turned over to the structure owner and have no post construction monitoring or adaptive management other than suggested owner's monitoring of the structural soundness of the nonstructural risk reduction measure on a regular basis. However, the nonstructural requirements and implementation is still undergoing development.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

The direct and indirect incremental impacts of implementing the TSP on valued environmental components, or significant human and natural environmental resources, determines if cumulative effects need to be addressed (USACE 2007) utilizing CEQ's 11-step cumulative effects analysis process (CEQ 1997). Cumulative impacts are the incremental direct and indirect effects on each significant human and natural resource identified above, caused by positively influencing over 6,000 acres of wetlands impacted by saltwater intrusion and inundation via hydrology/salinity control structures; restoring and nourishing over 12,500 acres of brackish and saline marshes; protecting over 5,500 acres (over 250,000 linear feet) of shoreline; and reforesting over 1,400 acres of chenier habitat. Tables 2-18 in Chapter 2 (a, b, and c) - SW Focused Array provides a full listing of each feature with quantities.

- Consistent with Step 1 of the CEQ 11-step process, this document has identified in previous sections the significant effects and issues associated with implementing the proposed action by documenting the direct and indirect effects of the proposed action on significant environmental resources.
- Consistent with CEQ step 2, this document has identified the geographic scope of the analysis as the area consisting of Calcasieu, Cameron and Vermilion Parishes.
- Consistent with CEQ step 3, the time frame of the analysis consisted of the historic, existing, future without project and future with project conditions for the identified significant natural and human environmental resources.
- Consistent with CEQ step 4, Other actions affecting the significant natural and human resources in the area include the following:
    a. CWPPRA program — 151 restoration/protection projects benefiting over 110,000 acres.
    b. LCA Program — the USACE and the State will continue to partner on the Mississippi River Hydro/Delta Management Feasibility Study. In addition, the State is expected to continue to partner with the USACE on the advancement of the Small Diversion at Convent/Blind River projects (currently in design), and to construct the Caminada Headland component of the Barataria Basin Barrier Shoreline project (currently in design by the State) and Demonstration Projects (currently developing program implementation

plans). The State has declined to participate in the LCA BUDMAT program; however, other non-federal cost share sponsors are presently being negotiated.

c. There are other Gulf shoreline protection and restoration projects that have been constructed along the Gulf shoreline through other funding sources. Segmented breakwaters have been constructed under at least two separate projects to the west of the proposed Holly Beach Shoreline Stabilization (5a) measure. The proposed breakwater would provide shoreline protection from the eastern end of the existing breakwaters eastward to the Calcasieu Pass jetty and compliment that existing project. The shoreline where the proposed Holly Beach measure would be built has been nourished with material dredged from the bottom of the Gulf of Mexico to help ensure that shoreline erosion did not compromise Louisiana Highways 27/82. Rock and rip/rap has also been placed at critical locations where shoreline erosion has threatened the highway. The proposed Holly Beach measure is compatible with and would augment these prior efforts. There have been proposals to construct shoreline protection measures along the Gulf shoreline where the proposed Gulf Shoreline Restoration: Calcasieu River to Freshwater Bayou (6b1, 6b2, and 6b3) measures are proposed, but no projects have been constructed.

d. The 2012 State Master Plan (CPRA 2012) — the State evaluated 248 restoration projects, 33 structural and 116 conceptual non-structural flood risk reduction projects. The State acknowledges that each project has its own timeline and budget.

e. Recreation: Temporary negative impacts of marsh restoration activities due to increased turbidity and possible boating access issues are mediated by the presence of other productive and popular recreation areas throughout the coastal region of Louisiana. Long-term positive cumulative impacts are expected to occur as restoration measures help protect recreational resource lands from effects of coastal storm surge while improving recreational opportunities by enhancing the sustainability of valuable nursery habitats.

f. Visual resources: The continued relative sea level rise could potentially impact the entire area resulting in vast areas of shallow open water as vertical accretion rates fail to keep pace with rising sea levels. Impacts to visual resources would continue throughout the not only the project area but coastal Louisiana and the Nation due to the loss of wetlands and conversion of existing habitats to open water habitats. However, wetland restoration efforts such as the CWPPRA, CIAP, and LCA Programs could restore the land would convert existing view sheds of open water into marsh, wetland, swamp or a variety of landscape types that frame large bodies of open water and use the basic design elements of form, line, texture, color and repetition to create an aesthetically pleasing view shed.

g. Kennish (2001) characterized anthropogenic impacts to coastal wetlands in the U.S. During the past century as human modification of environmental systems has greatly accelerated tidal salt marsh deterioration and shoreline retreat in many coastal regions worldwide. As a result, more than 50 percent of the original tidal salt marsh habitat in the U.S. has been lost. Human impacts at the local scale include those that directly modify or destroy salt marsh habitat such as dredging, spoil dumping, grid ditching, canal cutting, leveeing, and salt hay farming. Indirect impacts, which can be even more significant, typically are those that interfere with normal tidal flooding of the marsh surface, alter wetlands drainage, and reduce mineral sediment inputs and marsh vertical accretion rates. These impacts usually develop over a greater period of time. At the regional scale, subsidence caused by subsurface withdrawal of groundwater, oil, and gas has submerged and eliminated hundreds of square kilometers of salt marsh habitat in the Chesapeake Bay, San Francisco Bay, and Gulf of Mexico.

h. Deegan et al. (1984); Sasser et al. (1986); Swenson and Turner (1987); Delaune et al. (1989); Turner (1990); White and Morton (1997); Bryant and Chabreck (1998); and Kennish (2001) characterize human activities potentially threaten the viability of salt marsh systems on local, regional, and global scales. Direct impacts include those that result from the physical alteration and immediate loss of habitat during construction of bulkheads, dikes, weirs, levees, piers, docks, pipelines, revetments and other hard structures, as well as the excavation of canals, ditches, and oil drill sites.

i. The historic modifications of coastal marshes for agricultural purposes (e.g., draining and filling) and their reclamation for domestic and industrial development have substantially reduced viable wetlands habitat area during the past century (Adam, 1990; Anderson et al., 1992). Longer term, indirect impacts are also associated with some of these habitat disturbances. For example, the construction of impoundment dikes, water-control embankments, levees, dams for flood control, as well as canals and their associated spoil banks invariably alters the hydrology of these wetland systems, often interfering with normal tidal flooding and drainage, mollifying overland water flow, decreasing sediment supply to the marsh surface, and arresting vertical accretion.

j. According to Orson et al. (1985) coastal wetlands can respond to increasing sea level rise in three ways: (1) coastline retreat if the rates of coastal submergence exceed the vertical accretion of the wetland surface; (2) remain stable if sediment input from interior regions equals the rate of coastal submergence so that surface elevations are maintained; or (3) they can expand both vertically and laterally if the rate of coastal submergence is less than the sediment accretion rate. The failure of coastal wetlands to keep pace with sea level rise is generally ascribed to insufficient sediment deposition on the wetland surface leading to accretion deficits (i.e., vertical accretion is less than relative sea level rise). Delaune et al. (1983) and others have documented that, throughout coastal Louisiana wetlands are being replaced at an alarming rate by shallow open water.

- Consistent with CEQ steps 5 and 6, the responses of each identified significant resource to change has been documented for each identified significant human and natural resource. In addition, the factors or stressors potentially affecting significant human and natural resources, and if appropriate, their relationship to regulatory thresholds (e.g., air quality standards; designated critical habitat for the piping plover; threatened and endangered sea turtle activity windows for construction). According to the Louisiana Recovery Authority's 2006 "The Rita Report", the devastation Hurricane Rita left behind made it the third most expensive natural disaster in US history (source: http://lra.louisiana.gov/assets/docs/searchable/reports/RitaReportFinal091806.pdf). The Rita Report estimated almost $600 million dollars of damage to agriculture, forestry and fishing. More than 200,000 acres of fresh water and intermediate marshland was inundated with saltwater threatening native species on already-threatened environmentally sensitive wetlands. Hence, the southwest coastal Louisiana area, like the remainder of coastal Louisiana has been and will continue to be subjected to stresses which will continue the decline of environmental resources.
- Consistent with CEQ step 7, the baseline condition has been documented for each significant human and natural resources including the historic, existing and future without project conditions (Chapter 1). Consistent with CEQ step 8, the most important cause and effect relations include the direct impacts of the proposed action (non-structural risk reduction and ecosystem restoration along with the identified indirect impacts of the proposed actions. These incremental project-induced impacts would be in addition to other actions such as continued oil and gas exploration/extraction/production/refining, navigation, commercial and recreational fisheries, inhabitation and employment, other coastal protection and restoration activities, and other human activities in the project area.
- Consistent with CEQ step 9, the magnitude and significance of cumulative effects on identified significant resources include:
  a. Basin-wide influences, such as a reduction in the tidal prism resulting from over 12,500 acres of marsh restoration
  b. Parish-wide influences, such as from the nonstructural flood risk reduction measures reducing emergency response and rebuilding after tropical storm passage
  c. State-wide influences on commercial activities, such as from the import and export of materials from Lake Charles, which would be better protected from natural disasters.
- Consistent with CEQ step 10, during plan formulation the removal, modification or addition of alternatives to avoid minimize and reduce or mitigate potential significant effects included changes to design, construction and other measures including: removal of hydrology and salinity measures in the Calcasieu River and Sabine Lake because of potential adverse navigation impacts.
- With regard to CEQ step 11—monitoring effects of the proposed action and adaptation of management: an Adaptive Management and Monitoring (AM&M) Plan is included in Appendix A Annex L. The AM&M Plan will be further refined during the feasibility-level analysis phase based on comments of the Draft Report.

Alternative - Mermentau Small Integrated Restoration
Impacts would be the same as described for the Mermentau Basin component of the TSP.

2.5 Any Irreversible and Irretrievable Commitments of Resources Involved in the Implementation of the Tentatively Selected Plan

NEPA requires that environmental analysis include identification of "any irreversible and irretrievable commitments of resources which would be involved in the tentatively selected plan should it be implemented." Irreversible and irretrievable resource commitments are related to the use of nonrenewable

resources and the effects that the use of these resources have on future generations. Irreversible effects primarily result from use or destruction of a specific resource (e.g., energy and minerals) that cannot be replaced within a reasonable time frame. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the action (e.g., extinction of a T&E species or the disturbance of a cultural site).

The NER tentatively selected plan would result in the direct and indirect commitments of resources. These would be related mainly to construction components. Energy typically associated with construction activities would be expended and irretrievably lost under all of the alternatives excluding the no action alternative. Fuels used during the construction and operation of dredging equipment and barges would constitute an irretrievable commitment of fuel resources.

For the NER tentatively selected plan, most resource commitments are neither irreversible nor irretrievable. The dredging of borrow material is considered reversible although it is anticipated that the natural infilling of the borrow pits may take several years. Benthic communities would be removed and lost along with the sediment during dredging operations. Benthic communities would also take several years to recover. Fish and plankton would be entrained in the dredge during the dredging of the borrow areas. These losses would be irretrievable. However, most impacts to fish and plankton are short term and temporary and would only occur during dredging and construction activities. For example, access channels that would be dredged and retention dikes that are constructed would be restored to natural conditions after construction.

Other impacts, including disruption of community cohesion, may have longer effects that can be reduced through appropriate enhancement measures and best management practices. There are no irreversible or irretrievable commitments of resources which would preclude formulation or implementation of reasonable alternatives for this project.

2.6 Relationship between Local Short-Term uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

NEPA Section 102(2)(c)(iv) and 40 CFR 1502.16 requires that an EIS include a discussion of the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity. This section describes how the tentatively selected plan would affect the short-term use and the long-term productivity of the environment. For the tentatively selected plan, "short-term" refers to the temporary phase of construction of the proposed project, while "long-term" refers to the operational life of the proposed project and beyond. **Chapter 3** of the main report evaluates the direct, indirect, and cumulative effects that could result from the tentatively selected plan. Construction of the NER tentatively selected plan would result in short-term construction-related impacts within parts of the project area and would include to some extent interference with local traffic, minor limited air emissions, and increases in ambient noise levels, disturbance of fisheries and wildlife, increased turbidity levels, lower DO, and disturbance of recreational and commercial fisheries. These impacts would be temporary and would occur only during construction, and are not expected to alter the long-term productivity of the natural environment.

The NER TSP would assist in the long-term productivity of the ecological community in the three basins by improving the water quantity, water quality, nutrients, and sediments. This would facilitate the growth and productivity of emergent marsh and the invertebrates, fish, and wildlife that utilize these habitats. The NER tentatively selected plan would also result in enhancing the long-term productivity of the natural communities throughout the region. These long-term beneficial effects would outweigh the impacts to the environment resulting primarily from project construction.

With an increase in the amount wetland habitat and increase in wetland habitat quality, fish populations would experience beneficial impacts. These improvements in productivity would beneficially impact long-term commercial and recreational fishing in the study region.

2.7 Mitigation

Mitigation measures are used to avoid, minimize, or compensate for adverse impacts to environmental resources. The appropriate application of mitigation is to formulate a project that first avoids adverse impacts, then minimizes adverse impacts, and lastly, compensates for unavoidable impacts. No impacts have been identified that would require compensatory mitigation. No wildlife mitigation would be required. To reduce

fisheries related impacts all clearing and snagging will adhere to the Stream Obstruction and Removal Guidelines (1983). Air quality and noise impacts can be reduced by utilizing heavy machinery fitted with approved muffling devices that reduce noise, vibration, and emissions. A cultural resources monitoring program is recommended during the project implementation. This monitoring will consist of having a qualified archaeologist present during dredging activities. The purpose of the monitoring is to assure that no previously known or unknown archaeological sites are impacted during the implementation of this project.